Compress

PERMANENT FILE
IR
LITERATURE
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X-1850 IR 2M 10-54 PRINTED IN U. S. A.

MAY 1949

FIREWORKS FROM RAIL-MILL SAWS

Sparks fly as hot bars of rolled steel are cut into standard 39-foot lengths

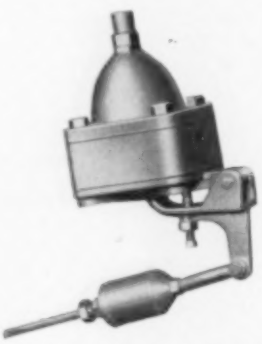
(SEE INDEX PAGE AND PAGE 103)

VOLUME 54 • NUMBER 5 NEW YORK • LONDON

A *Still-Better* REGULATOR FOR MOBIL-AIR *Compressors*

Ingersoll-Rand MOBIL-AIR AIR POWER

A New *Floating-Speed* Regulator for DRILL-MORE CAPACITY CONTROL



The UL-83 *Floating-Speed* DRILL-MORE Regulator retains all the advantages of Ingersoll-Rand's *original* Multi-Speed DRILL-MORE control for portable compressors, and provides many other superior features.

It automatically sets the exact and lowest practical compressor speed that delivers just enough air to maintain a constant air pressure. The speed "floats" with the demand for air.

- **Saves up to 40% in Fuel** by eliminating wasteful idling and always compressing the needed air at the slowest possible speed.
- **Holds 15- to 20-psi Higher Air Pressures.**
- **Up to 30% More Drill Power** . . . More Work from air tools.
- **Floating-Speed** . . . Eliminates speed steps . . . saves still more fuel.
- **Easier to Adjust** . . . Fewer parts . . . simpler in operation.
- **Compressor Loads and Unloads Only at Low Speed** and after reloading, speeds up only as much as needed . . . saves fuel, reduces wear and tear.
- **Reduces Maintenance** . . . Slower average compressing speed . . . unloaders operate fewer times . . . longer life of all parts.
- **Controls Engine Governor Instead of Carburetor** . . . Automatically compensates for temporary irregularities and prevents stalling.
- **Automatically Holds Engine at Low Speed During Starting** . . . Eliminates hand adjustments.
- **Ideal for Parallel Operation** *of unlimited number* of machines discharging into a common header.

Now standard on all KA-Series

105, 160, 210, 315 and 500-cfm sizes

DON'T STOP WITH A GOOD COMPRESSOR!

Use the IR CONTRACTORS' COMBINATION

- Everything you need for rock drilling.
- Top quality machines that work as a team.
- Machines designed, built, sold, and serviced by men who know rock excavation . . . application "know how"

AIR POWER The Key to Lower Costs

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y. 414-2

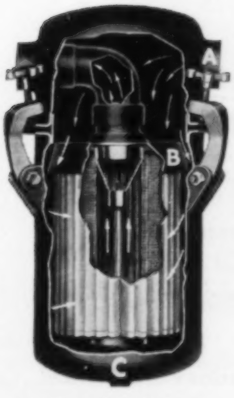
Simon Scrud

SCRAM, SCRUD!*

Stay Out of this Vacuum Pump

*Scrud: SCale, RUst, Dirt and other foreign matter in pipe lines

- *Scrud*—a word coined to describe all foreign matter drawn into vacuum pumps—may actually *double* wear on reciprocating parts. This excess wear is caused not only by abrasive particles, but by the washing away of essential lubricants. Staynew Filters *positively prevent* passage of all foreign matter. They frequently save their cost in a few weeks. Good engineering and good business demand Staynew Filters on *all* vacuum lines.



Sectional View of Model CVH

Radial Fin Insert

Operation

Staynew Vacuum Filters clean air by the exclusive Double Action Principle: With filter installed between process and pump, Scrud-laden air enters at (A), striking baffle (B). Here Mechanical Separation takes place, heavier particles of moisture and dirt being driven to bottom of container (C). Then air rises at low velocity thru the Radial Fin Insert which removes the lighter material by Filtration.

All Staynew Vacuum Filters Feature Famous Radial Fin Construction

Radial Fin Construction, an original Staynew development, is the most efficient form ever devised for the removal of foreign matter from pipe lines. Dry-type medium is used, providing positive filtration. *Resistance to flow is low,* due to the large filtering area possible in small space. Filter insert is easily removable and may be cleaned or replaced at low cost.

Complete Range of Sizes

Practically any size pipe line or CFM capacity can be accommodated. Standard sizes range from 60 CFM of free air with inlet and outlet connections of 1", to 825 CFM, connections 8". Special models are developed when necessary.

Representatives in Principal Cities

REQUEST BULLETIN B1-A FOR DATA

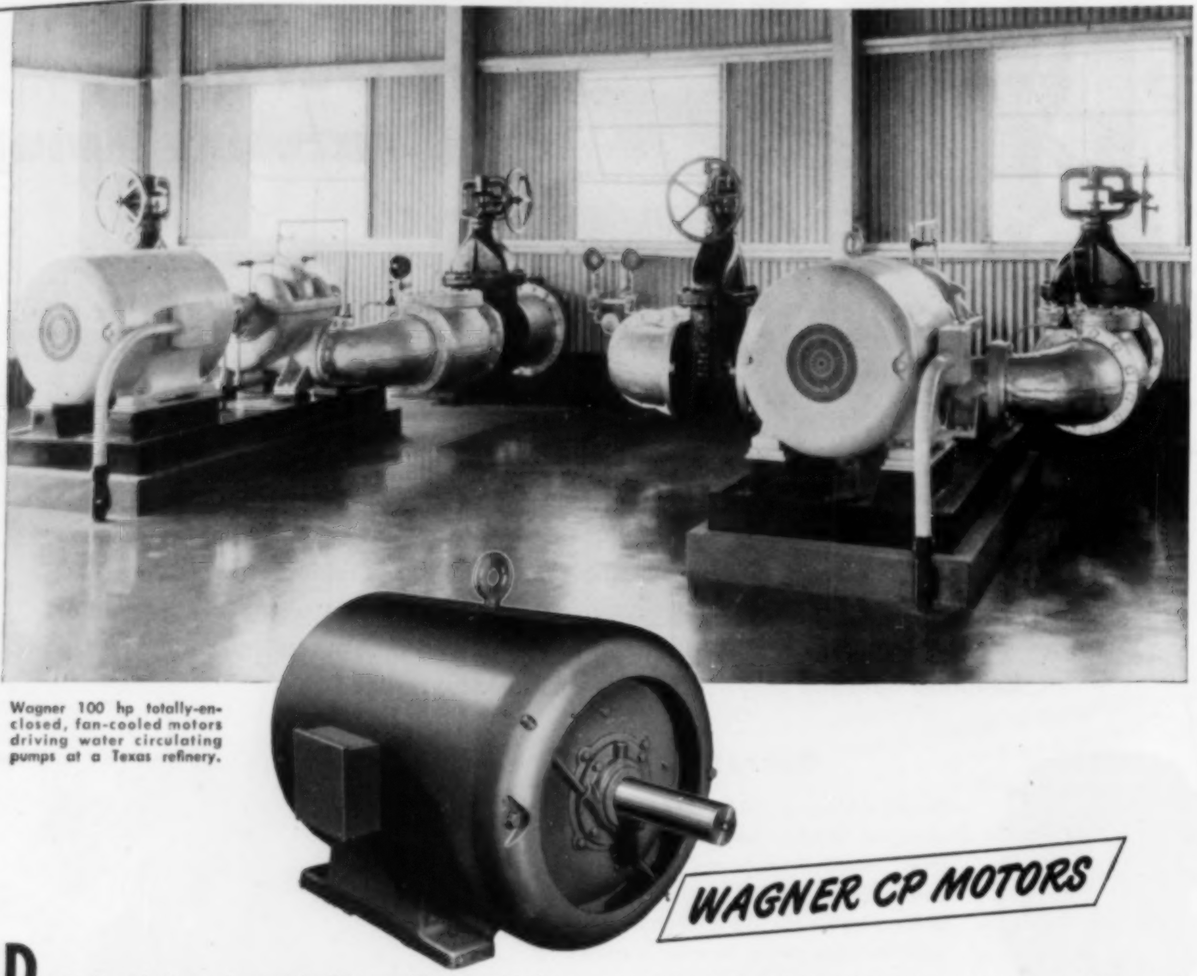
DOLLINGER REG. PROTECTOMOTOR U.S. PAT. OFF. STAYNEW FILTERS

DOLLINGER CORPORATION

7 CENTRE PARK • ROCHESTER 3, N. Y.

In Canada: McCarthy and Robinson, Toronto, Ont.
Engineering Equipment Co., Montreal, Que.

Pretty... but oh so TOUGH!



Wagner 100 hp totally-enclosed, fan-cooled motors driving water circulating pumps at a Texas refinery.

WAGNER CP MOTORS

Don't let their neatness fool you. These 100 hp Wagner totally-enclosed, fan-cooled motors do a giant-sized job—driving water circulating pumps at a Texas refinery.

Motors that drive pumps and compressors find the going tough. They must overcome back pressures set up by fluids or gases—they are often required to make repeated starts and stops—they are sometimes kept in continuous service.

But Wagner Motors can take it. There is a Wagner Motor correctly engineered to meet the requirements of every type of pump or compressor. You can choose the motor to fit your need from the wide variety of types and sizes in the Wagner line. Bulletin MU-185 gives full details.

Buyers of Wagner Motors get Nationwide Service! More than 450 Wagner Authorized Electrical Service Stations and Parts Distributors *plus* 25 Wagner-owned Service Branches are ready to immediately supply on-the-spot service, factory guaranteed exchange motors, or genuine Wagner parts. Write for Bulletin MU-24 for complete list.

Wagner Electric Corporation
6418 PLYMOUTH AVE., ST. LOUIS 14, MO., U. S. A.

Consult Wagner Engineers on all Electric Motor Problems

Wagner Electric Corporation EST. WE 1891

BRIDGE BRAKES • POWER AND DISTRIBUTION TRANSFORMERS • MOTORS • UNIT SUBSTATIONS
ELECTRICAL EQUIPMENT AND AUTOMOTIVE BRAKE PRODUCTS

M49-17

TALK VS. FACTS

COSTS ARE LOWER WITH

One of the things we tell you when you buy an Eimco RockerShovel is that the machine is designed for hard continuous service underground. We promise that it is so strong and rugged that it will do the toughest kind of work, year in and year out with surprisingly low maintenance costs—

Here is a factual proof:

For the past seven (7) years one of the toughest mining operations in the country has kept careful records on its more than 50 RockerShovels, these are the facts:

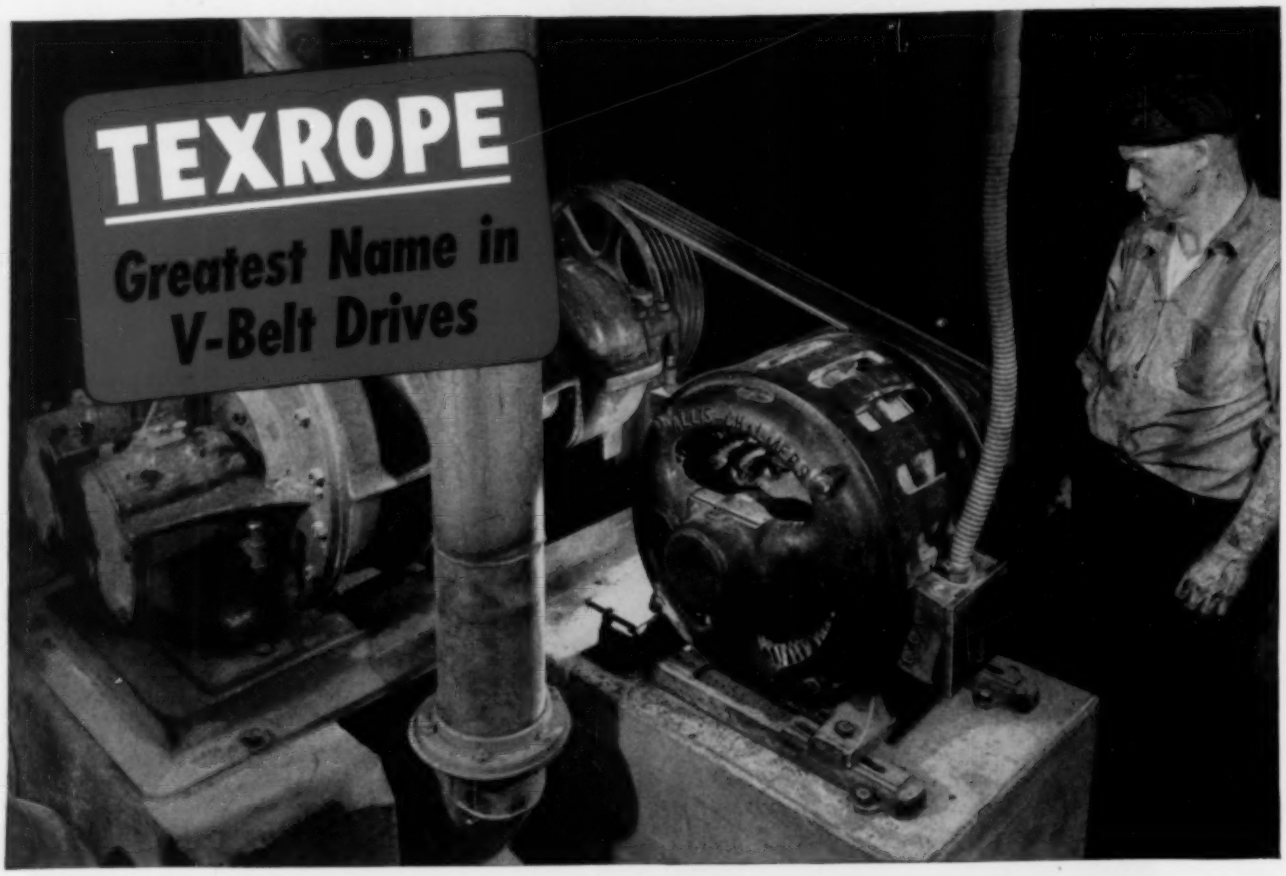
Loaded over 1⅓ million tons,
Cost .0142c per ton.

When you are next considering loading machines — demand this kind of performance.

EIMCO

THE EIMCO CORPORATION
The World's Largest Manufacturers of Underground Rock Loading Machines
EXECUTIVE OFFICES AND FACTORIES — SALT LAKE CITY 8, UTAH, U. S. A.
BRANCHES: NEW YORK, CHICAGO, BIRMINGHAM, EL PASO, SACRAMENTO, MANILA
AFFILIATED COMPANIES: SOCIETE EIMCO, PARIS, FRANCE
EIMCO (GREAT BRITAIN) LTD., LEEDS 12, ENGLAND
AGENTS IN ALL PRINCIPAL CITIES THROUGHOUT THE WORLD

A196



"No Upkeep Now"

BELT SLIP ELIMINATED, BEARING DAMAGE STOPPED, POWER WASTE ENDED WHEN *TEXROPE* V-BELT DRIVE REPLACES FLAT BELT.

CHIEF PLANT ENGINEER in this midwest plant says, "The old flat belt on this blower drive was twelve inches wide on twenty foot centers. Not only was it heavy but it also absorbed a lot of power.

"Besides that, dust made the belt slip constantly. We had to keep the belt so tight that it ruined bearings. And slipping would burn the belt. Maintenance on our old flat belt drive cost us hundreds of dollars every year.

"Four years ago an Allis-Chalmers representative recommended this *Texrope* drive. It doesn't slip at all, doesn't hurt the bearings and we haven't spent a cent on it. I wish we had changed to a *Texrope* drive years sooner."

Money-saving performance like this is one of the reasons why more *Texrope* industrial V-belt drives have been installed since 1926 — when Allis-Chalmers originated the multiple V-belt drive — than any other kind.

The *Texrope* line gives you practically everything you need for any V-belt drive . . . V-belts, standard and *Vari-Pitch* sheaves and speed changers . . . all from one reliable source. You can engineer 90% of all V-belt drives yourself with the help of the *Texrope* Pre-engineered Drive Manual. See your A-C Authorized Dealer or District Office or write for Bulletin 20B6956. Also in Sweet's.

Texrope Super-7 V-belts result from the cooperative research of Allis-Chalmers and B. F. Goodrich; and are sold only by A-C dealers and offices. *Texrope* and *Vari-Pitch* are Allis-Chalmers trademarks. A 2648

ALLIS-CHALMERS, 1000A SO. 70 ST.
MILWAUKEE, WIS.

ALLIS-CHALMERS

Sold . . .
Applied . . .
Serviced . . .

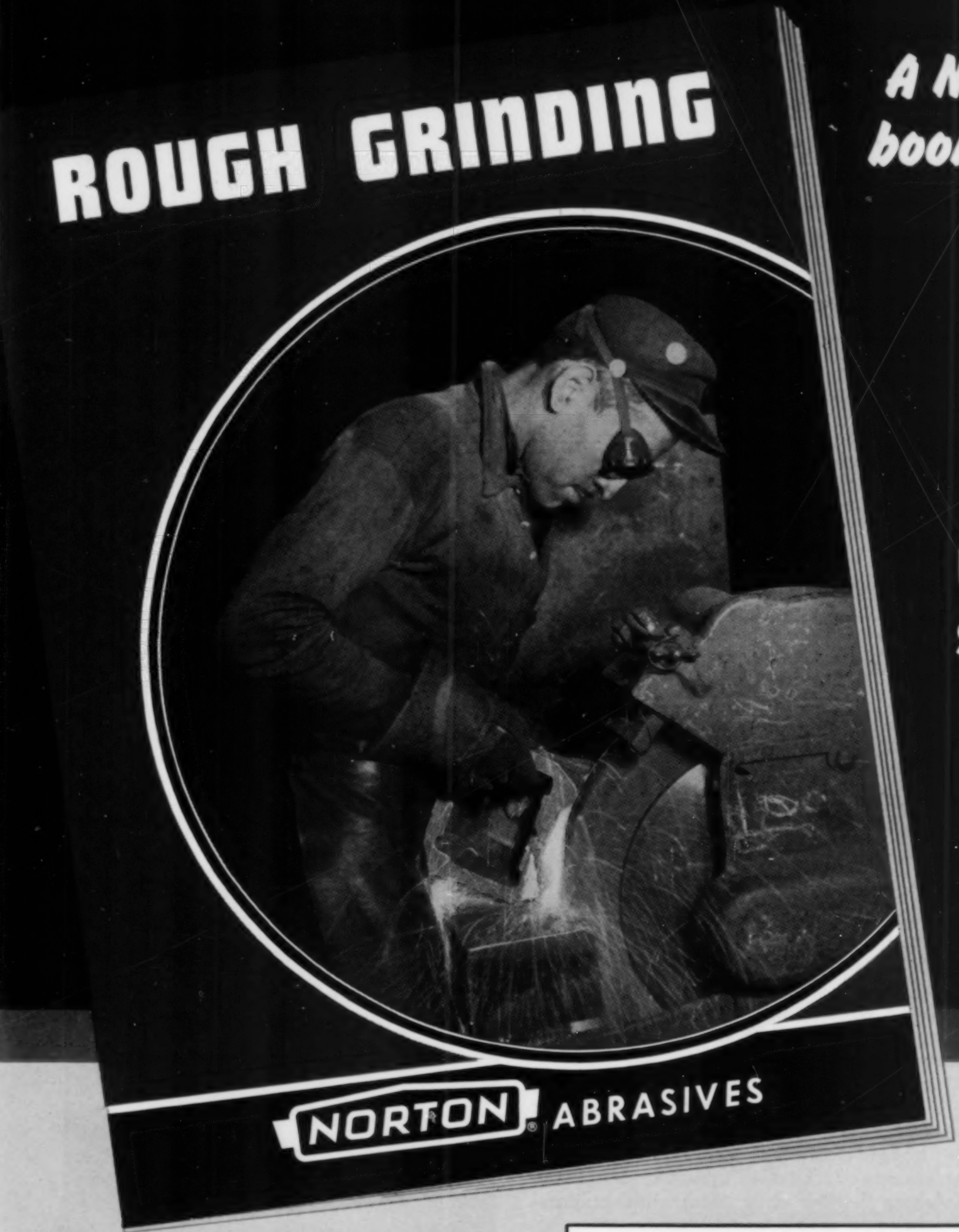
by Allis-Chalmers Authorized Dealers, Certified Service Shops and District Offices throughout the country.

MOTORS — ½ to 25,000 HP and up. Matching Allis-Chalmers Control.

TEXROPE — Belts in all sizes and sections, standard and Vari-Pitch sheaves, speed changers.

PUMPS — Integral motor and coupled types. Sizes and ratings to 2500 GPM.

48 Pages of Helpful Information-



ROUGH GRINDING

NORTON ABRASIVES

A New NORTON booklet just off the press!

for
Foundries—
Steel Mills—
Welding,
Forge and
Machine
Shops

YOU'LL find suggested specifications for the new fast cutting, long lived B-5 and B-7 resinoid wheels for grinding castings of steel, malleable iron (annealed and unannealed), gray iron, brass, magnesium and aluminum on floor stands, swing frames, portables and disc grinders: suggestions also for billet grinding, weld grinding and other rough grinding jobs.

Included too are specifications and list prices on mounted points, cut-off wheels (including the new NORFLEX reinforced resinoid wheels), rubbing bricks, and core files. There's a page on grinding wheel dressers and handy table of grinding wheel speeds. *Use this convenient coupon to obtain your copy*→

NORTON COMPANY • Worcester 6, Mass.

Please send a free copy of your new booklet, "Rough Grinding"— no obligation of course.

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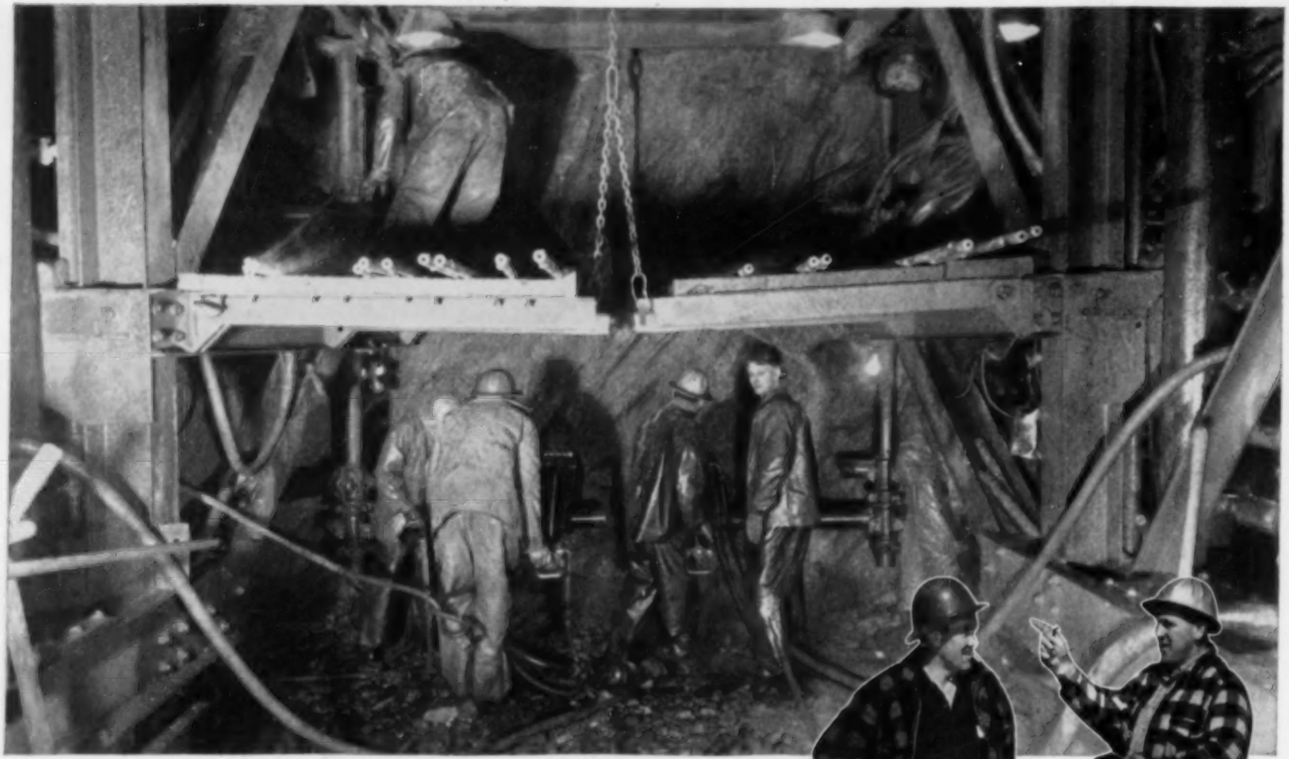


Here is one of Morrison-Knudsen's record-breaking drilling crews at the upstream face of their 4000-ft section of the 34,700-ft Rock Creek Tunnel. Contractors for other parts of the tunnel and dam construction work are: Walsh Construction Co., T. E. Connolly, Inc., and the Arundel Corp. & L. E. Dixon Co. All use Bethlehem drill steel.

L. E. Huntington, at left, tunnel superintendent for Walsh, is the uncle of F. A. Huntington (right), the "super" for Morrison-Knudsen. Rivalry is keen between these two contractors, each driving different ends of Rock Creek Tunnel.

New drilling records speed tunnel *at Feather River Project*

On Pacific Gas & Electric Company's $62,000,000 hydroelectric construction project in Northern California, two contractors using Bethlehem hollow drill steel have recently established what we believe are new all-time records.

Driving upstream from the site of Rock Creek powerhouse, Walsh Construction Company, drilling through the hard granite of Feather River Canyon, advanced 211 ft in six days during January—a record average of 35 ft per day.

Driving downstream on the same 25-ft diameter horseshoe tunnel, The Morrison-Knudsen Co., Inc., set the record for the most footage in 24 hours—47 ft driven on December 8.

Walsh uses Bethlehem hollow drill steel with detachable bits, averaging 4 or 5 drilling rounds of 10-ft depth per day. Morrison-Knudsen employs Bethlehem hollow drill steel with conventional forged bits.

Two other contractors on this project are users of Bethlehem drill steel. They are T. E. Connolly, Inc., constructing the main bypass and surge tunnels; and the Arundel Corp. & L. E. Dixon Co., driving the central, 24,000-ft section of the Rock Creek Tunnel.

General exterior view of the mouth of Rock Creek Tunnel (upper right) and Rock Creek Dam. This project will divert surging water from Feather River through tunnels to develop some 270,000 hp at two powerhouses for distribution to California industries.

BETHLEHEM
STEEL

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
On the Pacific Coast Bethlehem products are sold by
Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM HOLLOW DRILL STEEL

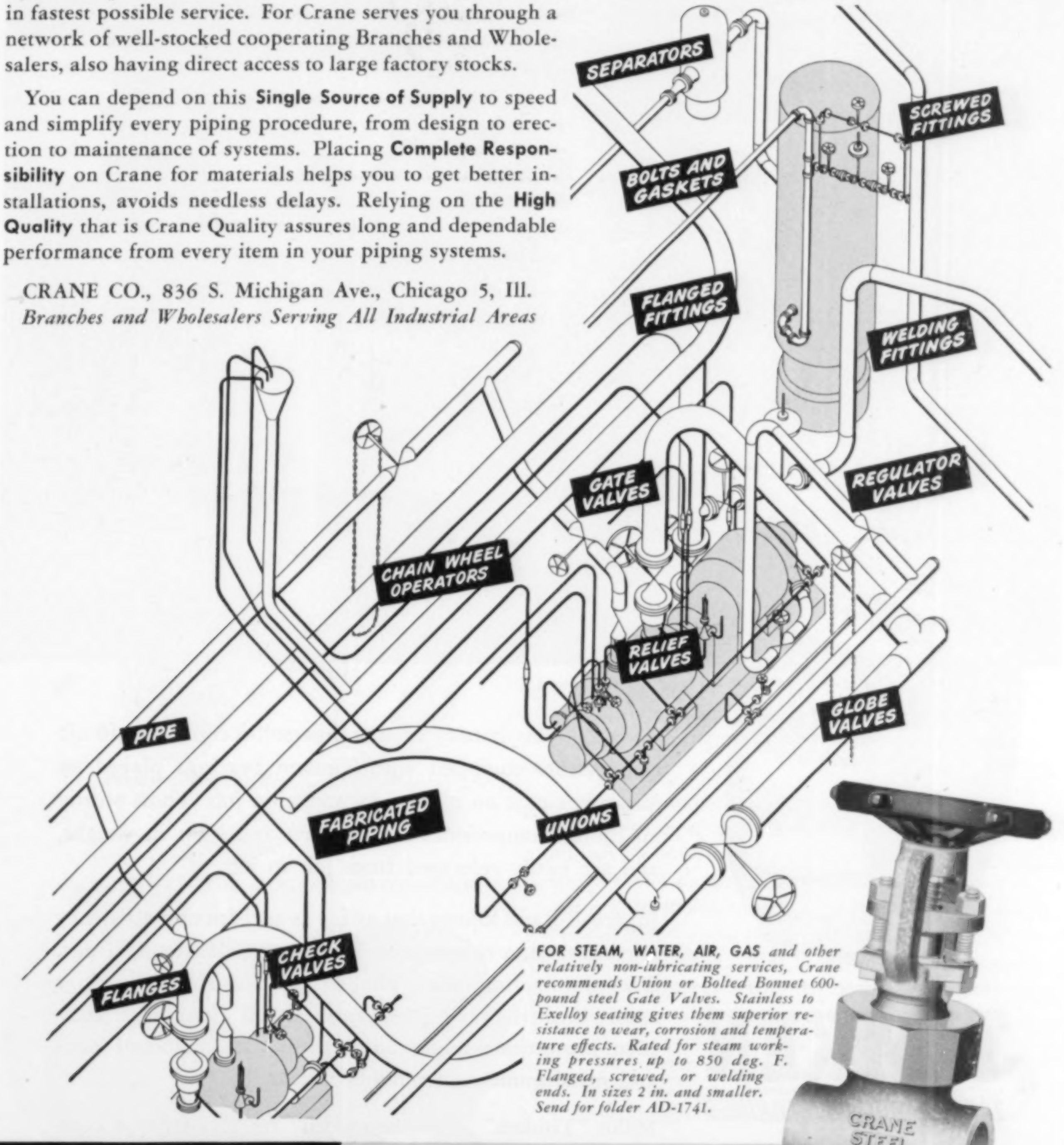
For every fluid...or working condition CRANE piping meets the need

For This Boiler Room Piping, for example . . . as for any pressure or temperature condition . . . Crane offers an unequalled selection of valves, fittings, pipe and accessories. One catalog lists the entire line. One order to Crane results in fastest possible service. For Crane serves you through a network of well-stocked cooperating Branches and Wholesalers, also having direct access to large factory stocks.

You can depend on this **Single Source of Supply** to speed and simplify every piping procedure, from design to erection to maintenance of systems. Placing **Complete Responsibility** on Crane for materials helps you to get better installations, avoids needless delays. Relying on the **High Quality** that is Crane Quality assures long and dependable performance from every item in your piping systems.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas

ONE SOURCE OF SUPPLY
RESPONSIBILITY
STANDARD OF QUALITY


SEPARATORS
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RELIEF VALVES
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FABRICATED PIPING
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CHECK VALVES
FLANGES
CRANE STEEL 600

FOR STEAM, WATER, AIR, GAS *and other relatively non-lubricating services, Crane recommends Union or Bolted Bonnet 600-pound steel Gate Valves. Stainless to Exelloy seating gives them superior resistance to wear, corrosion and temperature effects. Rated for steam working pressures up to 850 deg. F. Flanged, screwed, or welding ends. In sizes 2 in. and smaller. Send for folder AD-1741.*

EVERYTHING FROM . . .

CRANE

VALVES • FITTINGS
PIPE • PLUMBING
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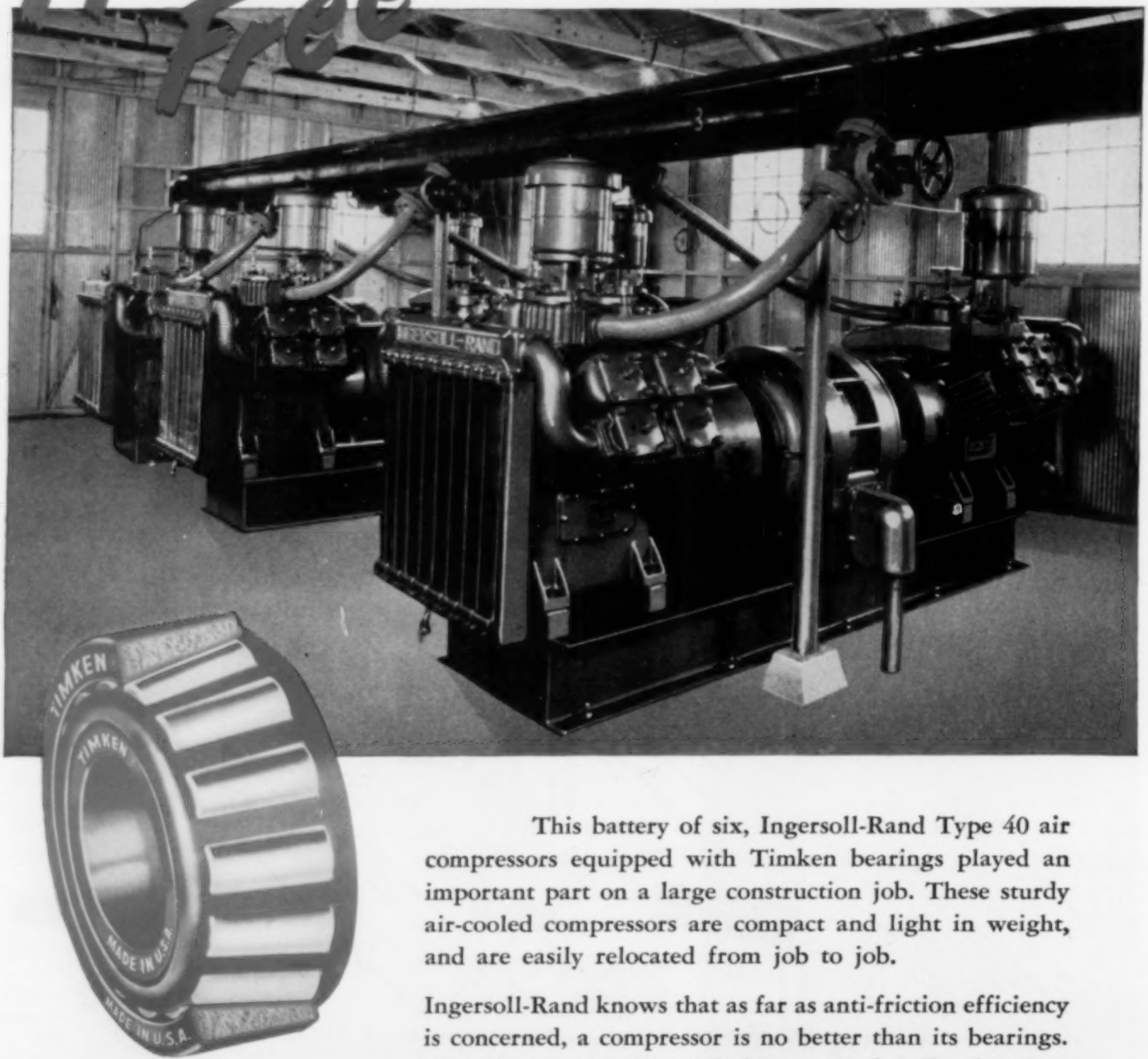
FOR EVERY PIPING SYSTEM

Friction-Free AIR-POWER PRODUCERS BY INGERSOLL-RAND



This battery of six, Ingersoll-Rand Type 40 air compressors equipped with Timken bearings played an important part on a large construction job. These sturdy air-cooled compressors are compact and light in weight, and are easily relocated from job to job.

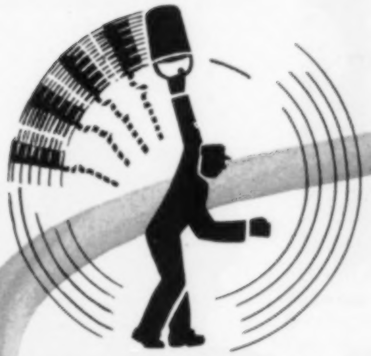
Ingersoll-Rand knows that as far as anti-friction efficiency is concerned, a compressor is no better than its bearings. They know, too, that Timken tapered roller bearings assure anti-friction performance in full along with complete protection against radial, thrust and combined loads and misalignment of moving parts.

Make "Timken" your "buy-word" for anti-friction compressors and all kinds of construction equipment. The Timken Roller Bearing Company, Canton 6, Ohio. Cable address "TIMROSCO".

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ↕ AND THRUST → ← LOADS OR ANY COMBINATION ✳

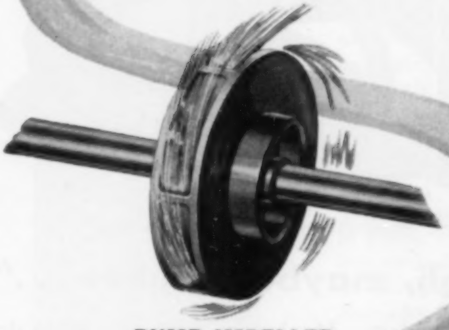
Let's get down to Pump Fundamentals



CENTRIFUGAL FORCE

EVER swing a small pail of water in a vertical circle? Never spilled a drop did you? Naturally, you know that centrifugal force kept the water in the pail by forcing it against the bottom of the pail. Had there been small holes in the bottom of the pail the water would have been forced through with considerable velocity.

Basically a centrifugal pump uses this principle. Liquid enters the eye of the impeller and is forced by centrifugal action through small volutes which increase in size to the perimeter of the impeller developing pressure. This pressure is the moving force of the liquid.

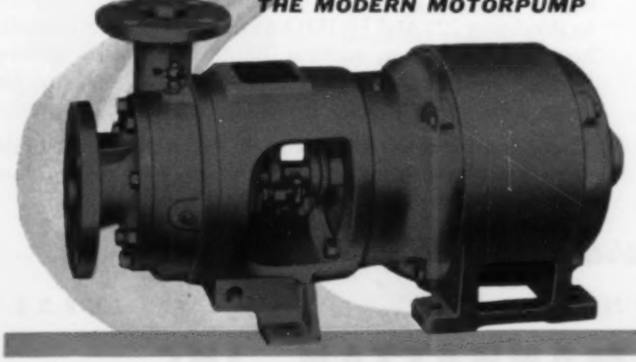


PUMP IMPELLER

The outstanding modern centrifugal pump is the Ingersoll-Rand MOTORPUMP. Its carefully designed and precision manufactured impeller and component pump parts gives top performance and reliability.

Look at the scope of just this one line of Ingersoll-Rand pumps, each a compact, self-contained unit with a built-in motor. From the many sizes and types of motorpumps you can select a unit from ¼ to 40 horsepower . . . 10 to 1800 gallons per minute - - - for heads to 600 feet . . . single and multi-stage. I-R Factory trained sales representatives across the nation will gladly help you with your present and future pumping problems. Prompt deliveries can be made from factory and branch stocks. Ask for catalogue No. 7093-A, which gives the complete story on Motorpumps.

THE MODERN MOTORPUMP

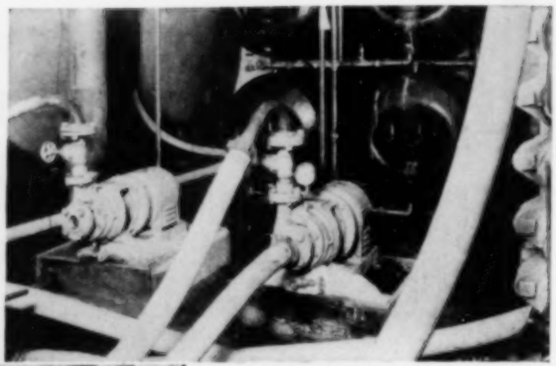


Ingersoll-Rand

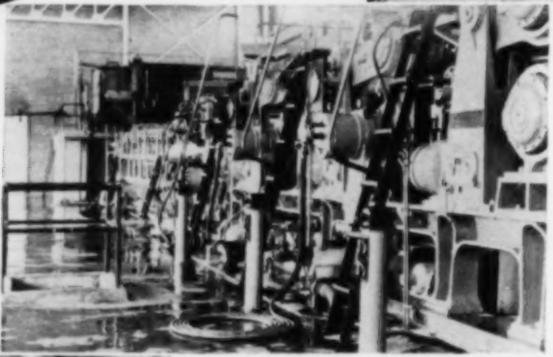
11 BROADWAY, NEW YORK 4, N. Y.

356-9

Distributor *Praises* MANHATTAN Hose *Engineering*

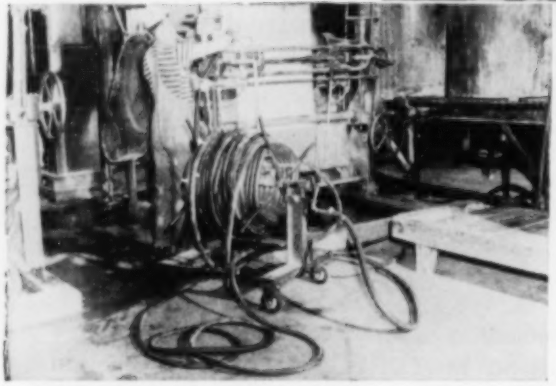


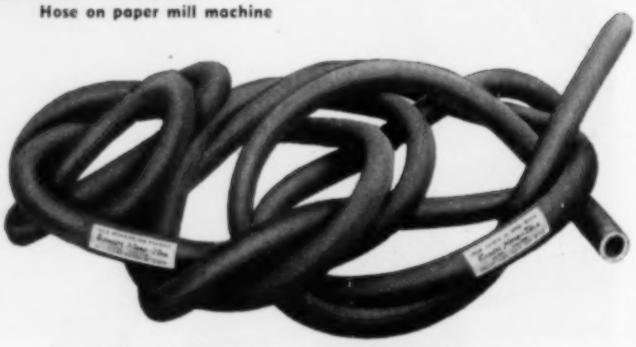
Hose on stationary carbonating pumps



Hose on paper mill machine

Hose for cleaning by air





Condor HOMO-FLEX Hose "Flexible as a Rope"

"Maybe your hose problem's not so tough, maybe tougher . . ."

". . . But whatever it is, chances are that Raybestos-Manhattan has a hose to solve it." This is the testimonial of the Lewis Supply Company, Memphis, Tenn.

One of their customers was having trouble handling anhydrous ammonia. Ice formed in the hose, which caused the hose to become brittle and to crack. Lewis Supply turned the problem over to Manhattan research men. They quickly developed a special "anhydrous ammonia hose".

This, of course, enabled this Raybestos-Manhattan distributor to render outstanding service to the customer. It's a story that has been repeated many times with many hose problems. Manhattan engineers have developed no less than 63 different types of hose, each for a specialized purpose.

Famous among Manhattan's standard constructions are CONDOR, for heavy duty jobs from sand blasting to dredging . . . and HOMO-FLEX, the easy-to-handle hose for air, water, suction, paint spray, etc. Newest development is RAY-MAN, made with rayon cord for extra light weight and flexibility on small air tools.

Many troublesome maintenance and equipment operating problems are eliminated when you make Manhattan your choice.

Keep Ahead With Manhattan

MANHATTAN RUBBER DIVISION — PASSAIC, NEW JERSEY

RM

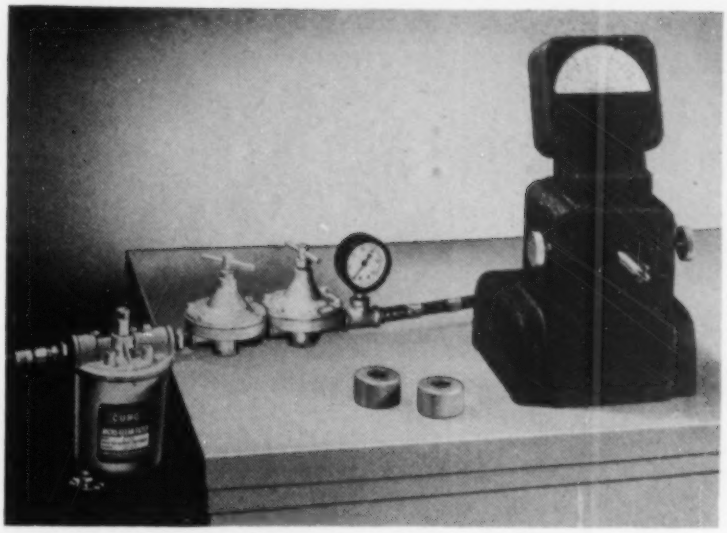
RAYBESTOS-MANHATTAN, INC.

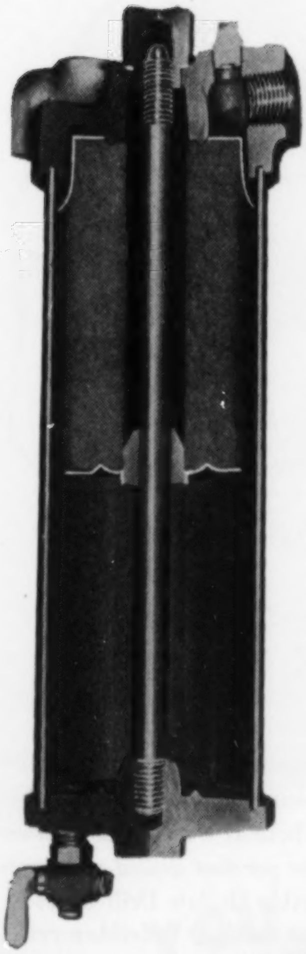
Manufacturers of Mechanical Rubber Products • Rubber Covered Equipment • Radiator Hose • Fan Belts • Brake Linings • Brake Blocks • Clutch Facings • Packings • Asbestos Textiles • Powdered Metal Products • Abrasive & Diamond Wheels • Bowling Balls

Clean Breath

HELPS PNEUMATIC EQUIPMENT DO BETTER WORK, LAST LONGER

Dial-type air-operated gages (Precisionaires) made by The Sheffield Corporation get air that is cleared of moisture, oil and other extraneous matter by passing through Cuno MICRO-KLEAN Filter . . . with the non-wicking cartridge that gives double the service and *cuts replacement costs in half.*

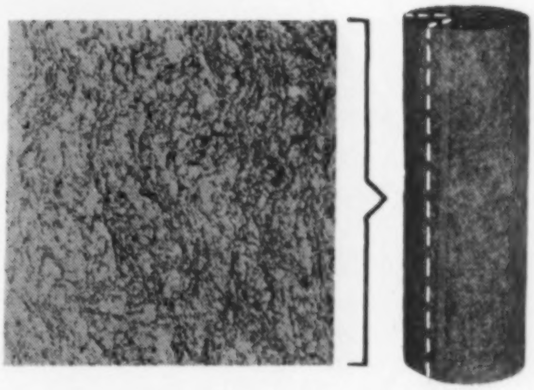




Plenty of Places to Get Lost

Air passing into the MICRO-KLEAN Filter first hits the baffle, deflecting some of the moisture down outside the cartridge. Any moisture remaining enters the cartridge where it must make hundreds of sharp turns, impinging on the non-wicking fibres, then draining into the extra-large collection chamber.

Standard Micro-Klean models handle volumes in excess of 450 cfm of free air and pressures up to 125 psi. They have been adopted as standard equipment on such widely divergent applications as pneumatic mine-equipment, powder dispensing devices, motor coach auxiliary air systems, spray painting systems, air instruments, etc.



No Wicking or Channeling

An exclusive method of "felting" fibres creates a network of tiny interstices in the cartridge. "Graded density in depth" prevents clogging, doubles dirt-collecting capacity. Resinous impregnation and polymerization eliminates "wicking" and strengthens the cartridge, preventing channeling.

- Your nearby Cuno engineering representative, handling the broadest line of fluid filters, is your best source of unbiased recommendations on fluid filtration . . . he offers you, before and *after* installation, service based on years of experience with engineering filtration systems.

CUNO

Fluid Conditioning

Removes More Sizes of Solids from More Types of Fluids

MICRONIC • DISC-TYPE • WIRE-WOUND

Cuno Engineering Corporation
177 S. Vine Street, Meriden, Conn.

Please send information on Cuno Filter.

Name...

Position...

Business Address...

PLEASE ATTACH COUPON TO YOUR BUSINESS LETTERHEAD

a bag of candy with the bill
-PARK A-
-PARK A-
-PARK A

Just as the grocer used to give you a bag of candy when you paid the bill, so you get extra value at no added cost when you use Crucible Hollow Drill Steel.

First of all, you get steel selected for controlled hardenability—steel with a wide quenching range that reduces your blacksmith's problems. Second, you get perfection of surface, not only on the outside but in the hole as well. Since stresses are concentrated on the surface, this means *lower cost per foot drilled* on tough jobs. Best of all, a sample of every shipment of Crucible Hollow Drill Steel is service tested under mine or field conditions on granite, an *exclusive* Crucible service.

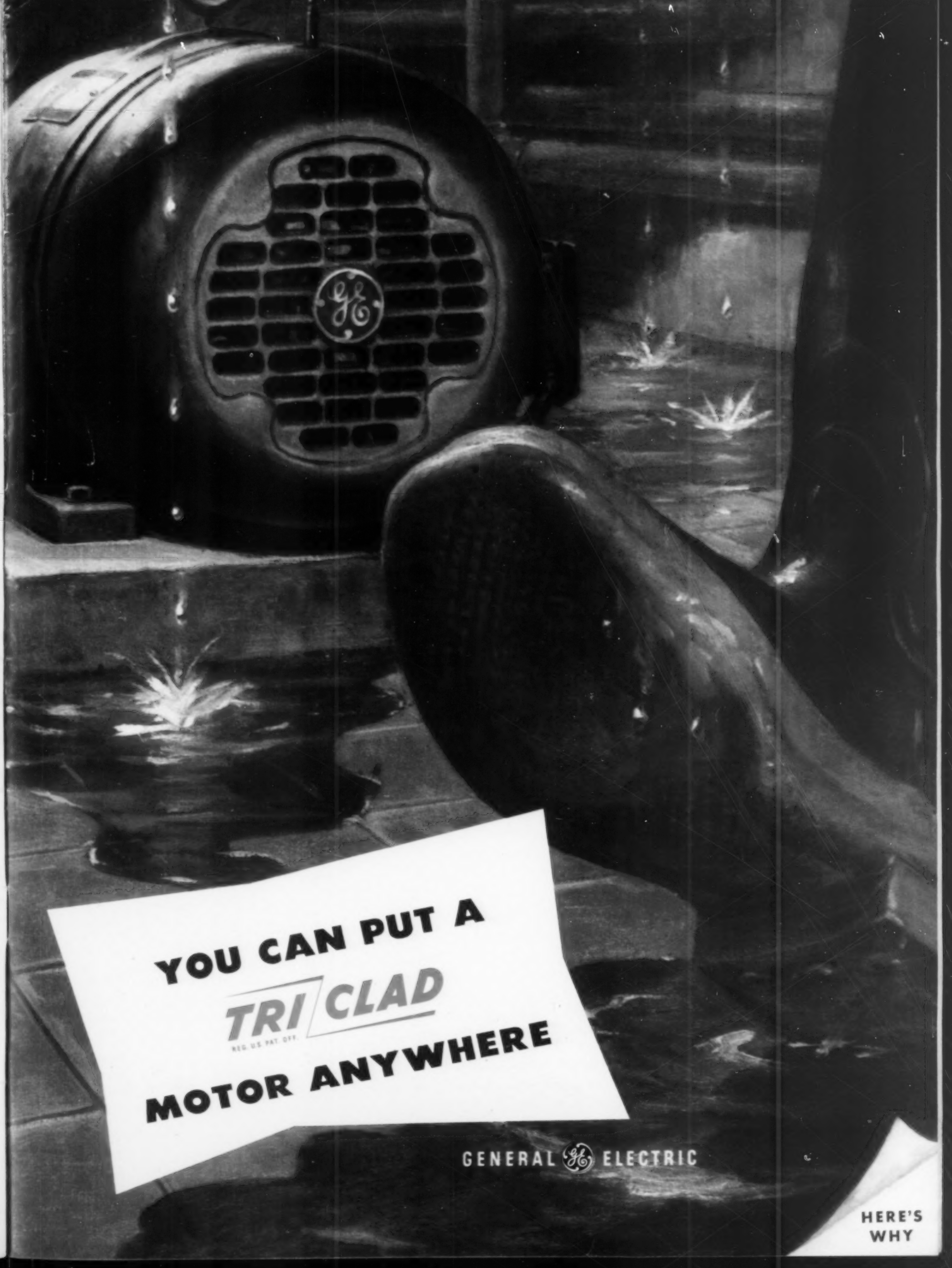
That's why you get an extra value that you can count on when you say, "Give me Crucible"—the top name for generations in special service steels.

CRUCIBLE first name in special purpose steels

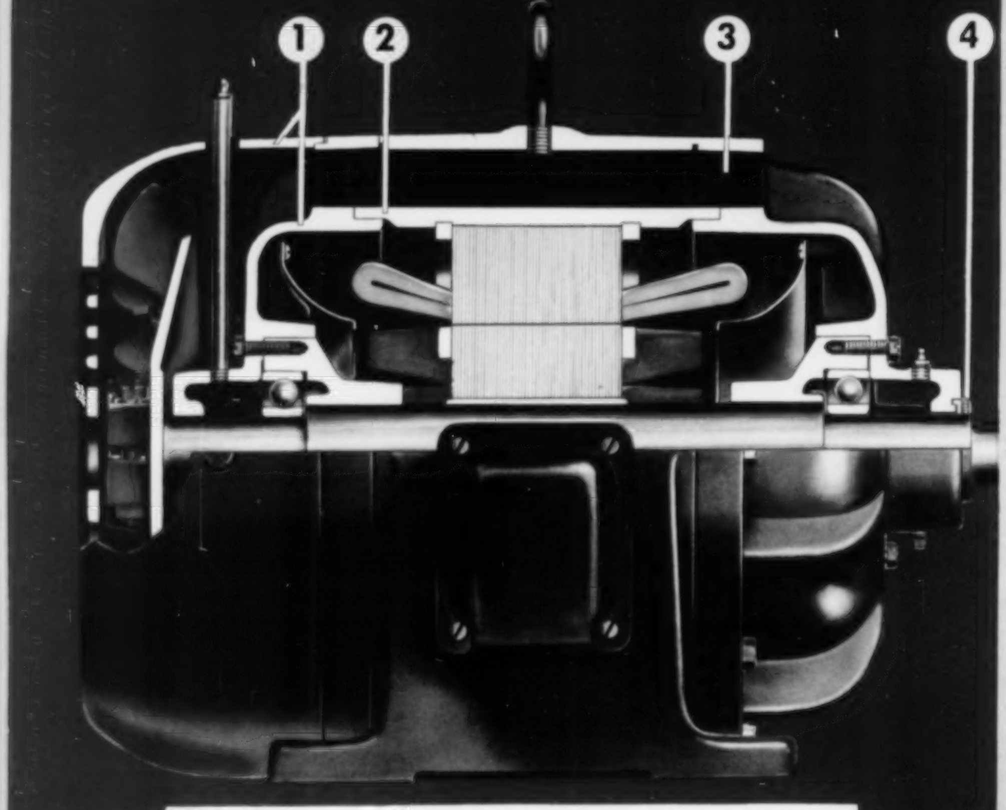
HOLLOW DRILL STEEL

CRUCIBLE STEEL COMPANY OF AMERICA, Chrysler Building, 405 Lexington Ave., New York 17, N. Y.
Branches, Warehouses, and Distributors in Principal Cities. Consult your Telephone Directory or Thomas' Register for Nearest Office.

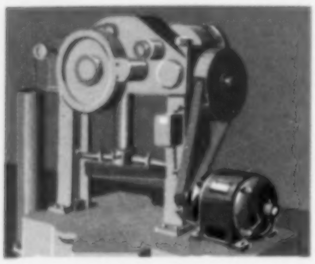
HIGH SPEED • TOOL • STAINLESS • ALLOY • MACHINERY • SPECIAL PURPOSE STEEL


YOU CAN PUT A
TRI CLAD
REG. U.S. PAT. OFF.
MOTOR ANYWHERE
GENERAL ELECTRIC
HERE'S WHY

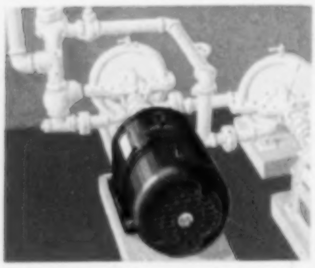
There's a Tri-Clad motor for every industrial need!



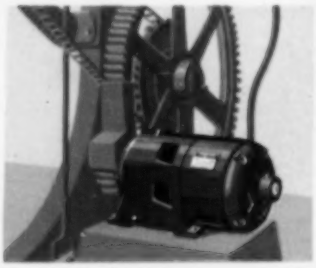
The standard totally enclosed Tri-Clad features a cast-iron double-wall structure (1) that keeps outside air from electrical operating parts . . . machined-fit end shields (2) . . . large air passages (3), easy to clean . . . rotating labyrinth seals (4) that keep foreign matter from working in around the shaft. Note, too, the new corrosion-resistant G-E Textolite cooling fan is now standard on all 1- to 15 hp TEFC Tri-Clads.



G-E open (dripproof) induction motors for constant-load, constant-speed applications. From 1 to 2000 hp.



G-E totally enclosed motors for outdoor operation, in abrasive dusts, or corrosive fumes. From 1 to 1000 hp.



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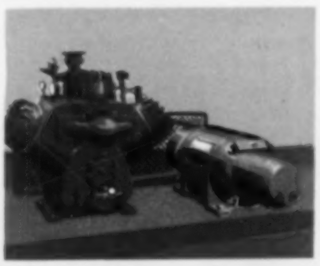

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EXTRA PROTECTION

GENERAL ELECTRIC

ON THE COVER

THE two million tons of rails used normally every year by American railroads are turned out by six steel mills. Their manufacture is a specialized operation that is rigidly controlled at every stage. Chemical composition of the metal, rolling temperatures and procedure, cooling time, and temperatures must all conform to exacting specifications. Test specimens from each lot rolled undergo minute inspection and rigorous physical tests. Should defective rails get into main-line tracks, they will soon be spotted by ingenious instruments in detector cars now employed by all first-class carriers. Because of these precautions rails now rarely fail in service. Ingots or blooms are gradually shaped in the mill by repeated rolling, each bar growing longer meanwhile. Emerging from the final roll, it and several companions go to hot saws to be cut into standard lengths, as shown on our cover.

●

IN THIS ISSUE

AMERICAN railroads spend more than a billion dollars annually in maintaining track and structures. The bill would be greater but for research that has given longer service life to rails and ties and developed effective mechanical equipment for keeping the track foundation in condition to withstand heavy traffic. We got our first railroad materials from England but didn't adopt all British standards. Instead, one of our pioneer railroad builders, Robert Stevens, designed the T-rail that has survived in a changing world. Our leader traces rail and track development.

●

MASS production of concrete on large construction jobs has been made possible largely through the development of ingenious and dependable compressed-air appliances and controls. An instance of how these time-and-labor-saving devices have been adopted by commercial concrete producers is given in an article (page 115) describing the operations of the Arizona Sand & Rock Company at Phoenix, Ariz.

●

THE article titled *On the Road to Guadalupe* (page 118) presents in pictures how 1000-hp. gas engine-driven compressors were moved 95 miles from the nearest railroad point to their foundations in one of the main pumping stations of the El Paso Natural Gas Company's transmission line extending from northern Texas to California.

●

ANOTHER pictorial layout (page 123) shows the step-by-step operations by which a contractor stopped erosion of a storm-fed stream that was threatening the security of main-line railroad tracks in Indiana.

Compressed Air Magazine

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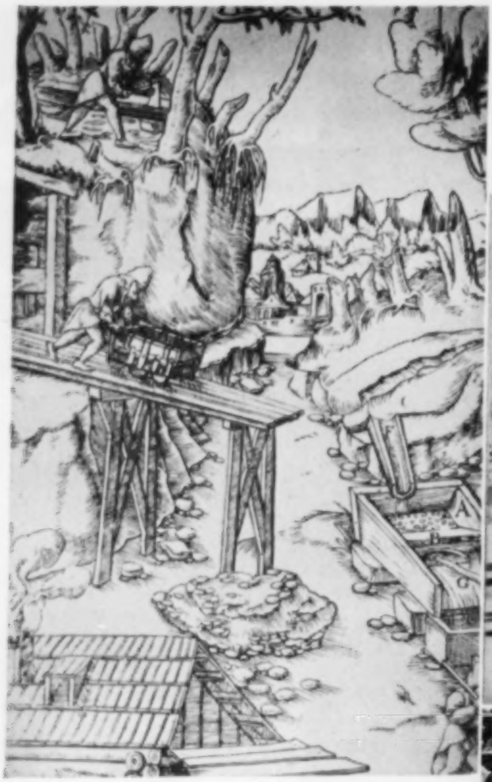
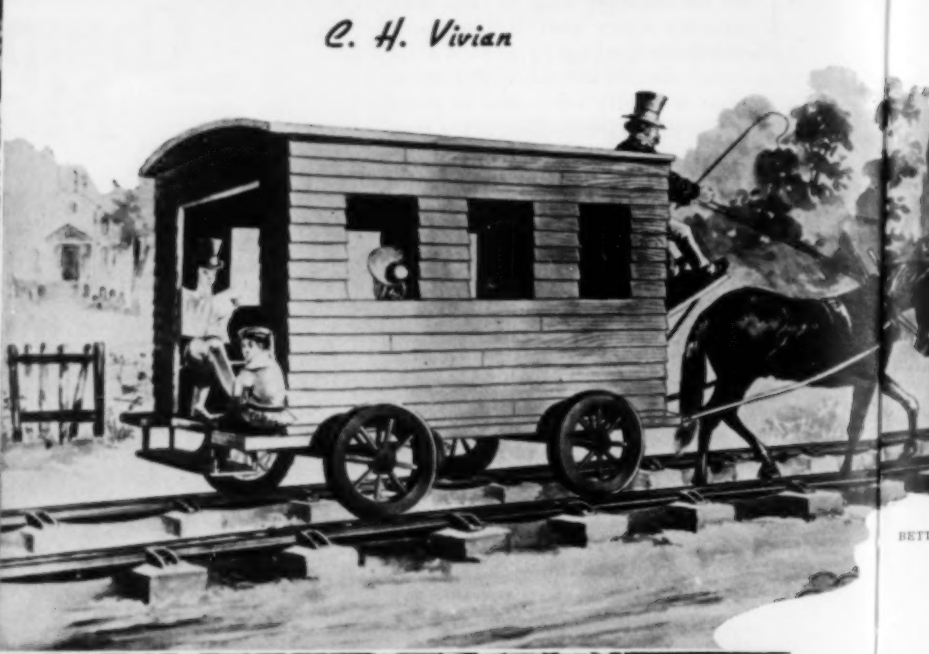
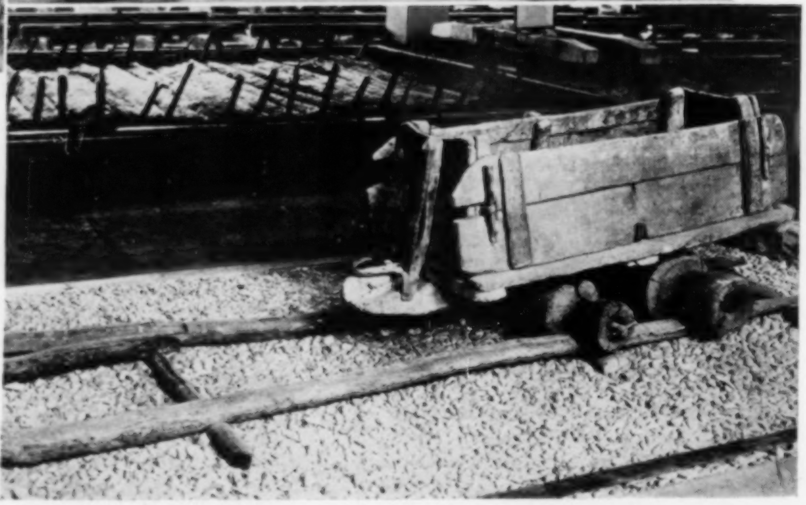
The Tale of the Rail

C. H. Vivian







THE FIRST RAILWAYS

At the upper-left is a reproduction of a woodcut from "The Book of Mines" by Agricola published in 1550. It shows a push car traveling on wooden rails in a mine. The museum exhibit directly above is a primitive wooden railroad that was used in a Hungarian gold mine in the sixteenth century. Each car wheel was fashioned from a single block of wood. A Baltimore & Ohio Railroad passenger car of 1830 is pictured at the top.

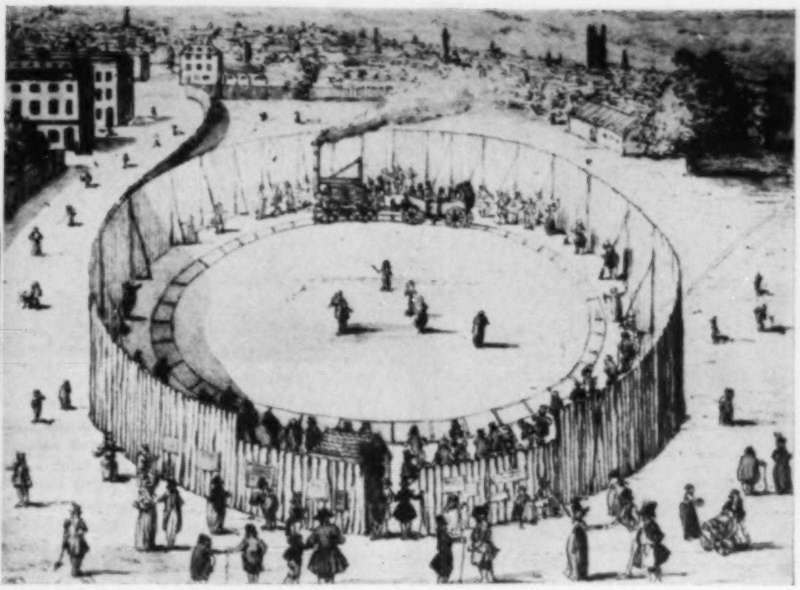
ASIDE from variations in width and height, a dozen lengths of rail taken at random from scattered points in the nation's 398,000 miles of track would look about the same. Viewed endwise, each would show the familiar shape of the letter "T" except for the broad base. This was not always true, however, for the high-T section, as it is known, did not become standard until many other shapes had been tried.

During our period of great railroad expansion, engineers of just about every new line followed their own ideas regarding rail design, and the result was utter confusion. It is reported that more than 900 different sections were in use at one time, and as late as 1881 mills were rolling 188 varieties. The first real step towards uniformity was the adoption of a list of standard sections by the American Society of Civil Engineers in 1893. The work thus started was taken up a few years later by the American Railway Engineering Association, which has ever since brought its controlling influence to bear not only on design but also on materials entering into all types of railway structures.

Although railroads did not originate in the United States, the T-section rail is distinctly American. In fact, it was used on one of our pioneer lines, the Camden & South Amboy Railway, which began operating in New Jersey in 1832. That was only three years after the Delaware & Hudson Company had put the *Stourbridge Lion*—the first locomotive in the Western Hemisphere—in service on a gravity line connecting its coal mines at Carbondale, Pa., with its canal at Honesdale a short haul away.

Prior to that time there were some lines on which cars were drawn by horses or pulled by cables from stationary engines. The earliest of these was probably an inclined plane used in Boston in 1795 for transporting brick. The longest was the Mauch Chunk Railroad in Pennsylvania which began moving anthracite a distance of 9 miles in 1827. Those railways had tracks of stone, wood, wood faced with iron strips, or solid iron. Rails of the latter material came from England and were naturally of British design.

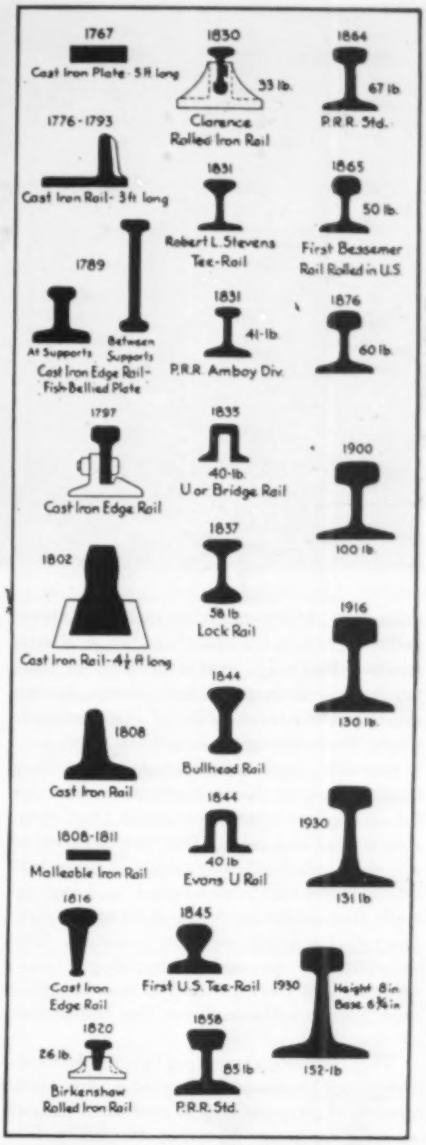
John Stevens visualized the Camden & South Amboy Railway long before it was built and received a charter for it from the State of New Jersey on February 6, 1815. Stevens was a lawyer who had become interested in transportation and was chiefly known for his development of high-pressure steam engines and boilers. He bought and for 50 years lived on the Island of Hoboken, just off the New Jersey shore in the Hudson River and opposite New York City. Later the island was connected to the mainland and became Stevens Point,



BETTMANN ARCHIVE PRINTS

TREVITHICK'S RAILWAY

Although the locomotive was suggested by Sir Isaac Newton as early as 1680 and later by other persons, Richard Trevithick, a Cornish mine captain, is credited with having built the first one in 1801. His second engine was constructed in 1803 with four smooth-tread wheels, all drivers and 4½ feet in diameter. Exhaust steam was turned back into the stack to promote combustion in the firebox. Trevithick demonstrated his creation, as shown here, on the site of Euston Square, London, in 1809. George Stephenson was the first to make the locomotive practical by building the Stockton & Darlington Railway in 1825. His famous "Rocket" was constructed in 1829 and won a prize of 500 pounds sterling offered by the Liverpool & Manchester line.


1767
Cast Iron Plate - 5 ft long
1776-1793
Cast Iron Rail - 3 ft long
1789
At Supports
Between Supports
Cast Iron Edge Rail - Fish-Bellied Plate
1797
Cast Iron Edge Rail
1802
Cast Iron Rail - 4½ ft long
1808
Cast Iron Rail
1808-1811
Malleable Iron Rail
1816
Cast Iron Edge Rail
1820
26 lb.
Birkenshaw Rolled Iron Rail
1830
33 lb.
Clarence Rolled Iron Rail
1831
Robert L. Stevens Tee-Rail
1831
41-lb.
P.R.R. Amboy Div.
1835
40-lb.
U or Bridge Rail
1837
58 lb
Lock Rail
1844
Bullhead Rail
1844
40 lb
Evans U Rail
1845
First U.S. Tee-Rail
1858
85 lb
P.R.R. Std.
1864
67 lb
P.R.R. Std.
1865
50 lb.
First Bessemer Rail Rolled in U.S
1876
60 lb.
1900
100 lb
1916
130 lb.
1930
131 lb
1930
Height 8 in.
Base 6¾ in
152-lb

AMERICAN IRON & STEEL INSTITUTE

CHRONOLOGICAL DEVELOPMENT OF RAIL CROSS SECTION

where Stevens Institute of Technology is now located.

Having purchased a ferryboat plying across the river, Stevens invented a multitubular boiler for marine-engine service and, to protect his rights, petitioned Congress in 1790 to enact a patent law. He was successful in this, and that legislation became the basis of our present patent system. He was the first to apply screw propellers to ships, and launched his *Phoenix* only a few days after Robert Fulton's pioneer *Clermont* made its first run. He himself had built the engine for it, whereas the *Clermont* was powered by a British engine. Because Fulton had been granted the navigation rights on the Hudson River, Stevens sent his vessel to Philadelphia. That was the first ocean voyage by steamship.

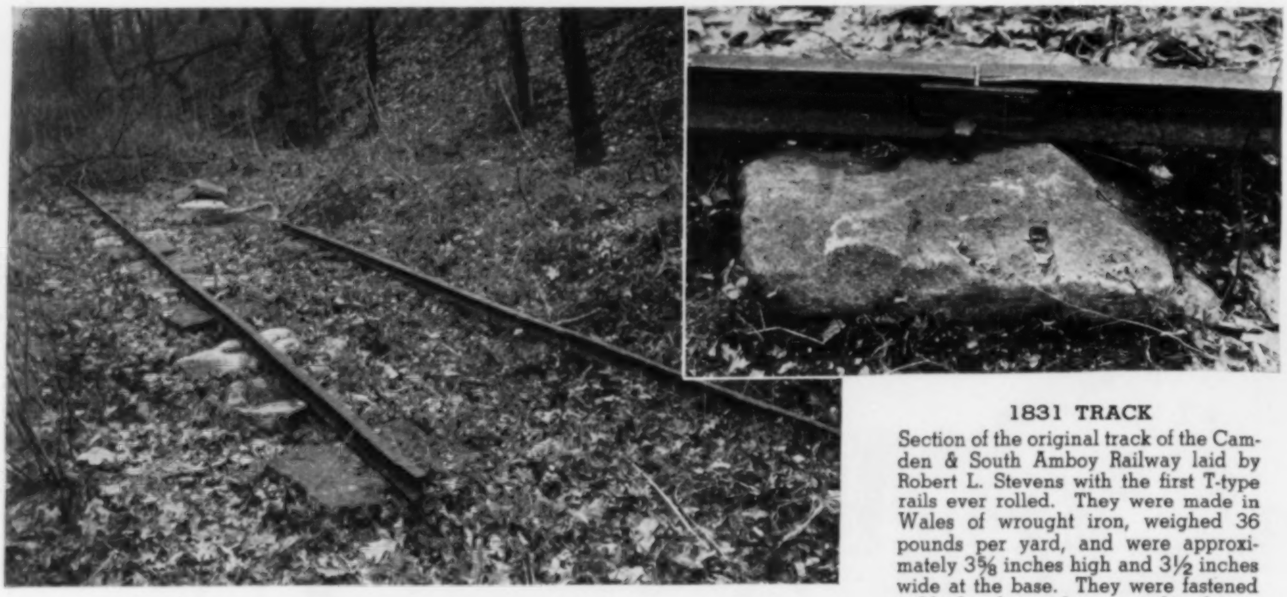
From that beginning Stevens widened his tranportation activities to include railroads. The Camden & South Amboy provided direct water-rail haulage between Philadelphia and New York. Passengers and goods moving up the Delaware River by boat from the former city were transferred to trains at Bordentown, just below Trenton, for the trip across New Jersey. At South Amboy, on Raritan Bay, another shift was made for the completion of the journey by boat. Construction of the line was begun in 1830 under the direction of Stevens's two sons, Robert L. and Edward A. The former was its first president and chief engineer and was destined to design the first T-type rail. He made a model of it while crossing the Atlantic Ocean on a sailing vessel for the purpose of ordering a locomotive from George Stephenson and rails from British ironmasters. The locomotive, which was built according to his specifications, was the 10-ton *John Bull*, which now reposes in the Smithsonian Institution in Washington.

Before he was out of sight of land, Stevens obtained some blocks of wood from the ship's carpenter and set to work with his pocketknife to carve out his conception of what a rail should be. British rails of that day varied in design, but none had a broad base. That was because they were set in iron chairs or cradles and not spiked to ties, as we do it. Our English cousins still build their tracks that way. Stevens planned to support his rails on blocks of stone set at regular intervals and sought to devise a flat base that would provide stability without the use of cradle mountings. Hence his whittling. After several attempts he got what he wanted, and the section of his model differed in only minor respects from that of one of our modern rails.

But designing the rail was the least of Stevens's troubles. Upon arriving in England he wrote letters asking various ironworks for prices and delivery dates on from 500 to 600 tons of rails made to his specifications. He received no replies, and it developed that the British ironmasters considered his project "dangerous, or at least highly imprudent and likely to prove disastrous to all concerned." Fortunately, Stevens was acquainted with John Guest, head of the Dowlais Iron Works in Wales, and he prevailed upon him to fill the order.

Stevens went to Wales and supervised the making of the necessary rolls. After they were ready the firm was reluctant to use them, fearing they might damage the mill. Whereupon Stevens deposited a sum sufficient to cover any repairs that might be needed. Millmen were unaccustomed to rolling rails of this design, and the first ones were as sinuous as snakes. However, the crews soon learned how to straighten them while they were cooling.

The first shipment to Philadelphia consisted of 550 rails, each 18 feet long and weighing 36 pounds per yard. In the next lot the weight had increased to 42



1831 TRACK

Section of the original track of the Camden & South Amboy Railway laid by Robert L. Stevens with the first T-type rails ever rolled. They were made in Wales of wrought iron, weighed 36 pounds per yard, and were approximately 3⅝ inches high and 3½ inches wide at the base. They were fastened to blocks of stone by iron spikes driven into drilled holes. The close-up, above, shows how the 18-foot rail lengths were joined by an iron bar riveted to the abutting ends. The bar is 6¼ inches long and 2¼ inches high. This piece of track has been preserved near Jamesburg, N. J., by the Pennsylvania Railroad. Some of it was taken up recently for display at an exposition and had not been restored to its original position at the time it was photographed. The rails show evidence of wear but little trace of corrosion.

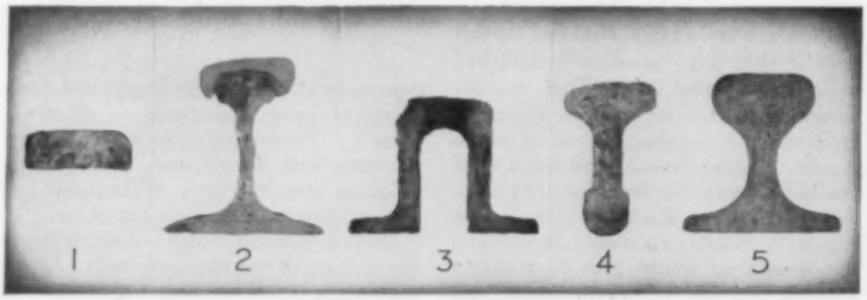
pounds. More than 30 miles of those rails were laid on the Camden & South Amboy Railway, and a section of that track is still in existence alongside the Amboy Division tracks of the Pennsylvania Railroad near Jamesburg, N. J.

Stevens had contracted with Sing Sing Prison in New York State for the 2-foot-square blocks of stone that were to support the rails. The first stretch of the road was built according to plan, but when stone deliveries failed to keep up with the crews he decided to try laying the rails on hewn, wooden crossties. The experiment proved surprisingly successful, and that method of construction was followed throughout the remainder of the line.

Ties had been used previously in Continental Europe and England, but their principal purpose was to maintain proper spacing or gauge between the rails. For fastening the latter to the ties Stevens designed a 6-inch-long, square-section spike with a head and a pointed lower end. It was almost identical in shape with the one found on American tracks today. Another Stevens conception was the flat joint bar or fishplate that serves to connect abutting rail lengths. At first he riveted it to the rails, but soon resorted to bolts such as are still used for the purpose.

Although iron had been produced in the American colonies since 1622, the development of rail-rolling facilities was slow, probably because of the difficulties of making the necessary machinery or obtaining it from abroad. Consequently, our early railroads had to import their rails, but the iron industry gradually became equipped to turn them out. While iron rails would soon fail under modern traffic conditions, they answered the needs of the pioneer roads fairly well. However, as the weight and speed of trains increased they became less and less satisfactory. Steel was being manufactured abroad in small quantities by the crucible process which Benjamin Huntsman had introduced in 1740, but it was too expensive to be used for rails. Fortunately, the Bessemer process, by which excess carbon is blown out of molten iron with compressed air, came along just when it was needed.

This pneumatic method of making steel, as it was then commonly referred to, improved railroad transportation everywhere and was largely responsible for criss-crossing the American continent with rails in the course of a few decades. Within a few months after Sir Henry Bessemer had first demonstrated his converter to British ironmasters in 1856 he rolled steel rails, and the first ones were laid in the main line of the Midland Railway at Derby Station, England, in 1857. In composition they were low in carbon and silica, high in sulphur and phosphorus, and contained varying amounts of manganese. By today's standards they would be considered poor rails, but they were a big improvement over their wrought-iron prototypes. The small mills operated slower than modern ones, and the rails were finished at a relatively low temperature that tended to produce a hard metal. Also, they were work-hardened to some



SECTIONS OF OLD RAIL

Photographs of rail sections, part of a collection owned by M. J. R. Morris, director of research for the Republic Steel Corporation at Massillon, Ohio. 1– Original cap rail from the Mad River & Lake Erie Railroad between Dayton and Sandusky, Ohio, that was chartered January 5, 1832, as the first line west of the Alleghenies. 2– Steel-capped, wrought-iron rail made in England and taken from Rock Island tracks near the LaSalle Street Station, Chicago, Ill. 3– U-section rail rolled by the American Iron Company at Mount Savage, Md., between 1836 and 1840. It was laid in a branch line of the Baltimore & Ohio Railroad. 4– English-made rail from a portage railway on an early Pennsylvania canal. It was set small end down in blocks of wood that were wedged between stone pillars. 5– Wrought-iron rail shipped in 1858 from England to Liberty, Tex., but never used because a projected line from there to Livingston, Tex., was not built. Unloaded on the bank of the Trinity River, the rails were covered to a depth of 18 to 24 feet when they were finally dug up.

extent under the light axle loads of the trains of that period.

The Pennsylvania Railroad was the first American common carrier to adopt steel rails. John Edgar Thompson, its president at that time, bought 400 tons in England for experimental purposes, and those rails were laid between Altoona and Pittsburgh, Pa., in 1862. They weighed 56 pounds per yard and cost $250 a ton, delivered in New York. It did not take long to prove their superiority over iron rails, and the Pennsylvania announced that it would standardize on them. Following that lead, other lines also changed gradually to steel.

A committee appointed by the American Society of Civil Engineers to study the comparative merits of iron and steel rails reported in 1876: "A steel rail wears out; an iron rail is knocked to pieces before it is worn out. Our (iron) rails do not give out for want of strength, but from injury to the head, not always perceptible to the eye." The greater durability of steel rails was especially evident on curves, where they lasted an average of five years, as against approximately four months for iron ones.

Because of the conflict over patents on the Bessemer converter and the one introduced almost simultaneously in this country by William Kelly of the Cambria Iron Company in Pennsylvania, the new steel-making process was not brought to bear in this country for several years and all our steel rails were meanwhile imported from England. The first ones rolled in the United States came from Capt. E. B. Ward's Chicago rolling mill in May, 1865, and weighed 57 pounds per yard.

Being one of the first persons in the industry to recognize the importance of the new technique, Ward, in 1863, became a director of the Kelly Pneumatic Process Company, which had built an experimental plant at Wyandotte, Mich., where Ward had another rolling mill. The first ingots of converter steel produced were turned over to him for the making of rails.

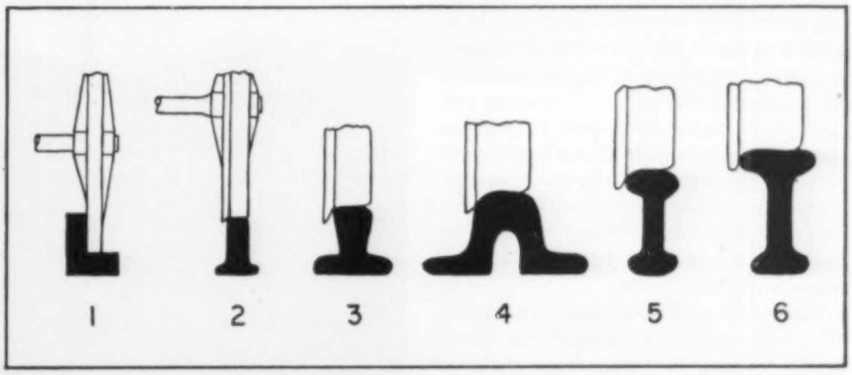
The first steel rails delivered to an eastern railroad are said to have been rolled by the Cambria Iron Company at Johnstown, Pa., from steel made by the Pennsylvania Steel Company at Steelton, Pa. Like Ward's they weighed 57 pounds per yard. Other concerns soon entered the field, and during the next twenty years half a million miles of steel rails were rolled and laid, serving materially to put the United States on the road to becoming the world's leading steel producer. The payroll of Ward's company grew to 6000 men. Its North Chicago rolling mill was the nucleus of the Illinois Steel Company, which became a subsidiary of the United States Steel Corporation in 1901.

During the infant years of our steel industry importation of rails continued, but at a diminishing rate. In 1867 we turned out 22,777 tons and obtained 145,579 tons from abroad. Despite a 45 percent protective tariff, Great Britain was then able to deliver rails at our eastern ports for $135.60 a ton, whereas the average cost of domestic rails was $168 a ton. Gradually our steel mills brought their prices down. By 1887 our rails were selling at $29.83 a ton, as against $39.15 for the British product, including $17 duty per ton. In that year our production was 2,101,904 tons, and only 137,588 tons were imported.

Meanwhile, although it was inevitable that steel rails should displace iron ones, some of our mills clung to iron and tenaciously resisted the change. In an effort to recapture lost business, they improved their product as much as they could. Finally, they tried welding a steel cap on to a wrought-iron base, but that was not entirely successful and also proved too expensive a process to compete with steel. The output of iron rails attained a peak of 808,866 tons in 1872, as against 83,991 tons of the steel product. In the ensuing years the trend reversed rapidly, and in 1877 steel rails were in the lead, 385,000 to 296,000 tons. The banner year of rail production was 1906, when the tonnage reached 3,977,887. Of that total, iron accounted for only 15 tons. No iron rails have been made here since 1911. Total American output to date of both iron and steel rails has exceeded 160,000,000 tons.

While steel and iron were battling it out, a transition was underway in the method of making steel. The Siemens open-hearth process, first applied in England in 1867 and in this country in 1870, turned out steel that was superior in some respects to Bessemer steel for rails. The product was higher in carbon, lower in phosphorus, and not so brittle. Because toughness is one of the major attributes of a good rail, open-hearth steel was bound to prevail. However, the changeover was far from abrupt. The first open-hearth-steel rails were not rolled in the United States until 1878, and Bessemer rails led until 1911. The real impetus in the trend was attributable in large measure to the opening of the huge Carnegie-Illinois Steel Company open-hearth mills at Gary, Ind., in 1909.

For a long time, as already mentioned, the technical staffs of the railroads wrote their own specifications for rails. As late as the close of the last century there were few recognized standards, and the rail then being made did not give satisfactory service. The situation was becoming more serious all the while because increasing wheel loads imposed continually greater demands. To bring order out of chaos, seventeen interested engineering and maintenance men from different railroads met in Chicago on October 21, 1898, to discuss the formation of an organization that would investigate all matters relating to track structures and



RAIL EVOLUTION

The modern railroad evolved from "wagon-ways" that served Great Britain in the seventeenth century. In order to move greater horse-drawn loads of minerals such as coal and stone, wooden planks were laid in ruts worn in roads by cart wheels. To hold the planks in place, cross members, known as ties, were added. Because the planks wore out quickly, someone thought of covering them with thin strips of iron. When the wooden wagon wheels, in turn, were worn down unduly by the metal, iron wheels were adopted. As traffic increased, the iron strips frequently worked loose, and this brought about the first attempt to cast solid-iron rails. The initial lot, turned out at Coalbrookdale Iron Works in 1767, had an L-shaped section, as No. 1 shows. The wheels ran outside of the upright members to hold them on the track. The gauge was 5 feet, in conformity with the span between the opposed wagon wheels. Next came the edge rail (No. 2). The wheels ran on top of them and were provided with a flange on the inner side to prevent derailment. This resulted in shortening the span to 4 feet 8½ inches, which is still standard gauge in the United States. Those rails were set in chairs or cradles, usually on stone pedestals. In 1836, C. B. Vignoles introduced the flat-bottomed rail (No. 3) which eliminated the chair because it could be spiked directly to ties. On the Great Western Railway, I. K. Brunel used the bridge rail (No. 4) in an effort to save metal. In 1835, Joseph Locke developed the double-headed rail (No. 5). It could supposedly be reversed, but practice proved that that was prevented by wear on the base at the point where it rested in the chairs. Modification of the Locke design produced the "bull-headed" section (No. 6) which is now standard on British railroads make suitable recommendations for the guidance of all carriers.

As an outgrowth of this conference, the American Railway Engineering Association came into being in 1899, just 50 years ago. It now functions as the research arm of the Association of American Railroads, and its effect on the physical properties of the nation's lines has been marked. It works through committees made up of members that study problems assigned to them. Last year it spent $350,000 on research, most of the funds coming from the railroads. In addition, $16,000 was received from rail manufacturers for special work in connection with rail failures and $20,000 from lumbermen for an investigation relating to ties. It engaged in 26 separate projects which required the services of its own 20-man research staff and the laboratory facilities of four engineering colleges and two private agencies.

At the outset, the AREA undertook to simplify the design of the rail section and, that accomplished, to persuade the various railroads to accept it. That led to the adoption, in 1908, of American Railway Association designs Types A and B in which the rail height was one-tenth greater than the base width, with the sides of the intermediate web member sloping at an angle of 1 in 16. Those relationships were retained in newer designs known as RE sections. The efforts were so successful that more than 75 percent of the rails rolled during World War II consisted of 112- and 131-pound RE sections, which had been generally agreed upon by the railroads for main-line track. More recently, improved rail sections weighing up to 152 pounds per yard have been developed to replace those just mentioned. They were made possible by the use of electronic stress-measuring equipment, which is also responsible for recommended changes in the spacing of bolt holes to reduce stresses near rail ends.

One of the outstanding accomplishments was the virtual elimination of rail failure caused by transverse fissures. This type of defect first attracted attention in 1911, and by 1920 had assumed proportions that alarmed railroad officials. A transverse fissure is the result of a nucleus within the rail head and is revealed after breakage by a silvery, oval spot. Coöperating with the AREA, the late Dr. Elmer Sperry developed an electric detector car in 1928, after five years of work, which makes it possible to locate these internal flaws and remove the rails before they fail.

Nearly all railroads now run detector cars over their main tracks at regular intervals. In 1943, they were responsible for the replacement of 51,505 defective rails. Through additional research it was determined that the cause of transverse fissures could be eliminated by controlling the rate of cooling rails after they are rolled. Since that discovery in 1937, practically all rails have received special attention while cooling, and transverse fissures are now almost unknown.

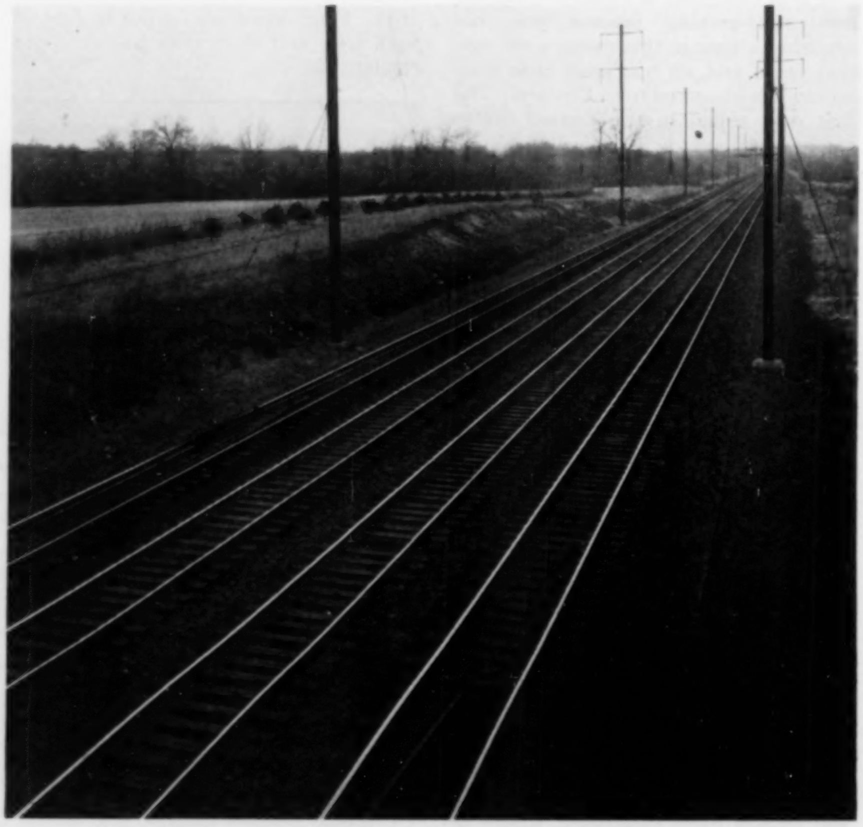
Every rail produced today is marked to show the mill that made it, the year and month it was rolled, the heat or batch it came from, and the ingot as well as the part of it from which it was taken. This permits checking any defect against the mill records and comparing the performance of rails produced at different times by each mill. Because of these diverse research efforts, rails now have an average service life of fifteen years in main-line track.

As in the case of rails, the AREA has lengthened the service life of ties. When it began its studies, yearly tie replacements averaged 300 per mile; now the figure is around 115. Of 100 million ties removed from track in 1900 only 1 percent had been treated with a preservative and only about 2½ percent of the substitutes were treated. Most roads were skeptical about the benefits of creosoting. Tie plates interposed between the rails and ties to protect the latter were rarely used, and those that were did little good. They were too small to distribute the weight to any great extent and had a variety of prongs, barbs, ribs, and gouges that cut into shreds the tie areas on which they rested.

Because the technique of wood preservation was more advanced in Europe than in the United States, the AREA brought over a young German plant pathologist, Dr. Herman von Schrenk, and added him to its staff. Seven sizes of ties were recommended in 1904 and specifications for them written. Until then the railroads had specified a minimum size of tie, and oversized ones were paid for at the same rate. It is now recognized that a larger tie is better than a small one, and each is priced according to size.

Few railways kept records of the service obtained from ties, so the AREA got up a standard report form that is now widely used. Data thus gathered give accurate information on tie life and make it possible to evaluate the worth of new methods of treatment. When a shortage of white oak and other good tie woods threatened, studies were made of possible substitutes. By 1940 ninety varieties of concrete, steel, and composition ties had been examined in 201 installations. Tropical woods also were tried. In the end it was determined that native woods are the best tie material.

In 1928 von Schrenk wrote a paper

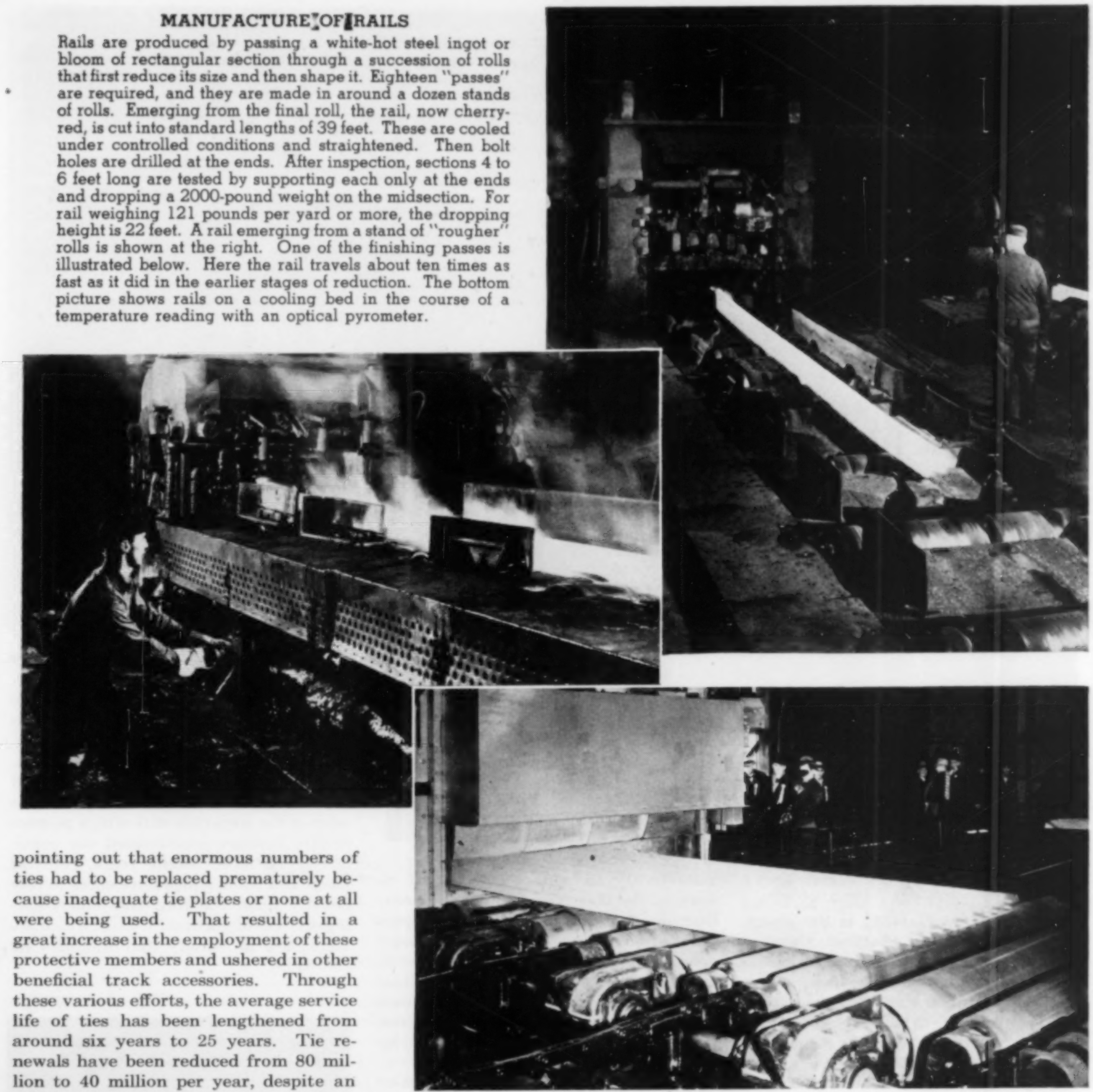


HIGH-SPEED TRACK

A section of the electrified New York-Philadelphia line of the Pennsylvania Railroad near Monmouth Junction, N. J. Notice the clean line of the ballast toe at the right and the generally well-kept appearance. All rail weighs 152 pounds per yard.

MANUFACTURE OF RAILS

Rails are produced by passing a white-hot steel ingot or bloom of rectangular section through a succession of rolls that first reduce its size and then shape it. Eighteen "passes" are required, and they are made in around a dozen stands of rolls. Emerging from the final roll, the rail, now cherry-red, is cut into standard lengths of 39 feet. These are cooled under controlled conditions and straightened. Then bolt holes are drilled at the ends. After inspection, sections 4 to 6 feet long are tested by supporting each only at the ends and dropping a 2000-pound weight on the midsection. For rail weighing 121 pounds per yard or more, the dropping height is 22 feet. A rail emerging from a stand of "rougher" rolls is shown at the right. One of the finishing passes is illustrated below. Here the rail travels about ten times as fast as it did in the earlier stages of reduction. The bottom picture shows rails on a cooling bed in the course of a temperature reading with an optical pyrometer.



AMERICAN IRON & STEEL INSTITUTE PHOTOS

pointing out that enormous numbers of ties had to be replaced prematurely because inadequate tie plates or none at all were being used. That resulted in a great increase in the employment of these protective members and ushered in other beneficial track accessories. Through these various efforts, the average service life of ties has been lengthened from around six years to 25 years. Tie renewals have been reduced from 80 million to 40 million per year, despite an interim increase in track mileage from 262,684 to 384,000 and a greater volume of traffic moving at considerably higher speeds.

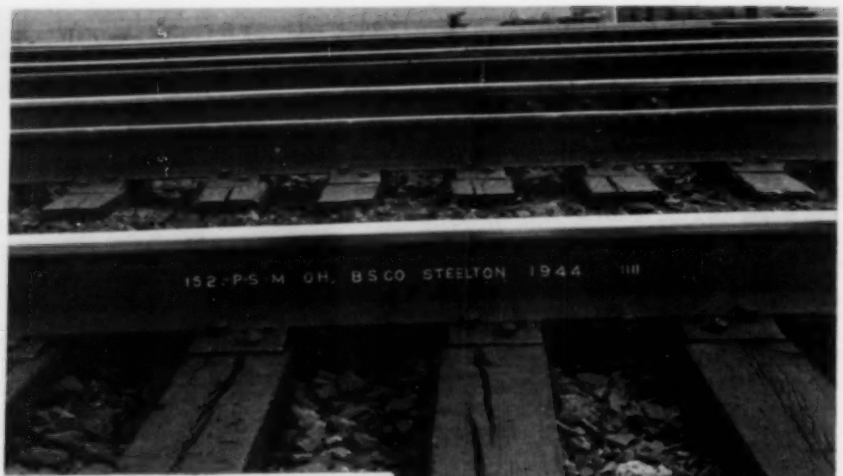
The AREA also concerns itself with the proper ballasting of track. No one seems to know just who pioneered in this field. W. S. Lacher, secretary of the organization, states that "practice in ballasting is something that 'just growed,' and I doubt if there is any record of who conceived the idea of using something other than the material of which the roadbed is constructed as an improved bedding for the cross ties. Even today, practice in the use of ballast is influenced by practical considerations such as the availability of materials that will serve the purpose."

The functions of ballast as defined by *Railway Maintenance and Engineering Cyclopedia* are: 1, to provide a firm even bearing for the ties and to distribute the loads as evenly as possible over the roadbed; 2, to provide adequate drainage of the track structure and thus prevent "puddling" or "pumping" track, and to minimize heaving as a result of freezing (thorough drainage also aids in prolonging the service life of ties); 3, to fill the spaces between adjacent ties and to form a shoulder between the ends of ties and the toe of the ballast slope in order to hold the ties in place; 4, to assist in preventing the growth of vegetation within the limits of the tracks; 5, to facilitate track work in wet weather.

For best results, ballast material should be of fairly uniform size and not so large as to add to the expense and difficulties of tamping. It must be relatively free from fine particles, which tend to fill the voids and prevent adequate drainage. It must have sufficient locking power (such as crushed stone possesses) to prevent the shifting of ties under traffic, but it must also have characteristics that enable it to be readily handled and worked. Good ballast should have strong resistance to disintegration under all weather conditions, including freezing and thawing, and its consistency should not change when wet. Furthermore, it should have good resistance to breakage and disintegration under the impact of tamping tools and the wave

MODERN TRACK STRUCTURES

Below is a view along the ballast slope on the outside of the Pennsylvania Railroad's 4-track line near Monmouth Junction, N. J. Notice the uniform size and cleanness of the crushed stone, which is of igneous origin. Repeated additions of ballast following track settlement have built it up to a depth of around 3 feet. The pipe running along the left edge is an air line for operating switches. The control tower is in the left background. At the right are shown raised identifying rail markings. They indicate that the rail is of 152-pound section manufactured to Pennsylvania System specifications of open-hearth steel by Bethlehem Steel Company at Steelton, Pa., in 1944, fourth month. The rail is 8 inches high and 6¾ inches wide at the base.



motion of rails and ties under heavy traffic.

In general, availability is the governing factor in ballast selection. Crushed stone such as granite or other igneous rocks is preferred, but as these source materials occur in scattered areas their cost is prohibitive in many sections of the country. Economic considerations have resulted in the employment of a wide variety of materials, including crushed limestone, crushed smelter and blast-furnace slag, prepared and pit-run gravel, chat, oyster shells, locomotive cinders, and others. Of these, the AREA classes crushed stone, crushed slag, and sized gravel as "prepared" ballast and recommends that no other be used for heavy-duty track except under special circumstances. It issues detailed specifications to which these materials should conform to be acceptable.

The advent of air-powered tie tampers had a great bearing on the economy and efficiency of tamping ballast and was a boon to section crews. The tool was invented by George W. Vaughan, formerly Engineer of Maintenance of Way of the New York Central Railroad. Ingersoll-Rand Company acquired the exclusive license to manufacture it, and the first units used commercially were put to work on the New York Central line near Dumont, N. J., in 1913. Those tampers were powered by a portable compressor mounted on railroad wheels and developed by Ingersoll-Rand. This original outfit was retired in 1928 after fifteen years of service and donated by the New York Central to the Smithsonian Institution for permanent exhibition.

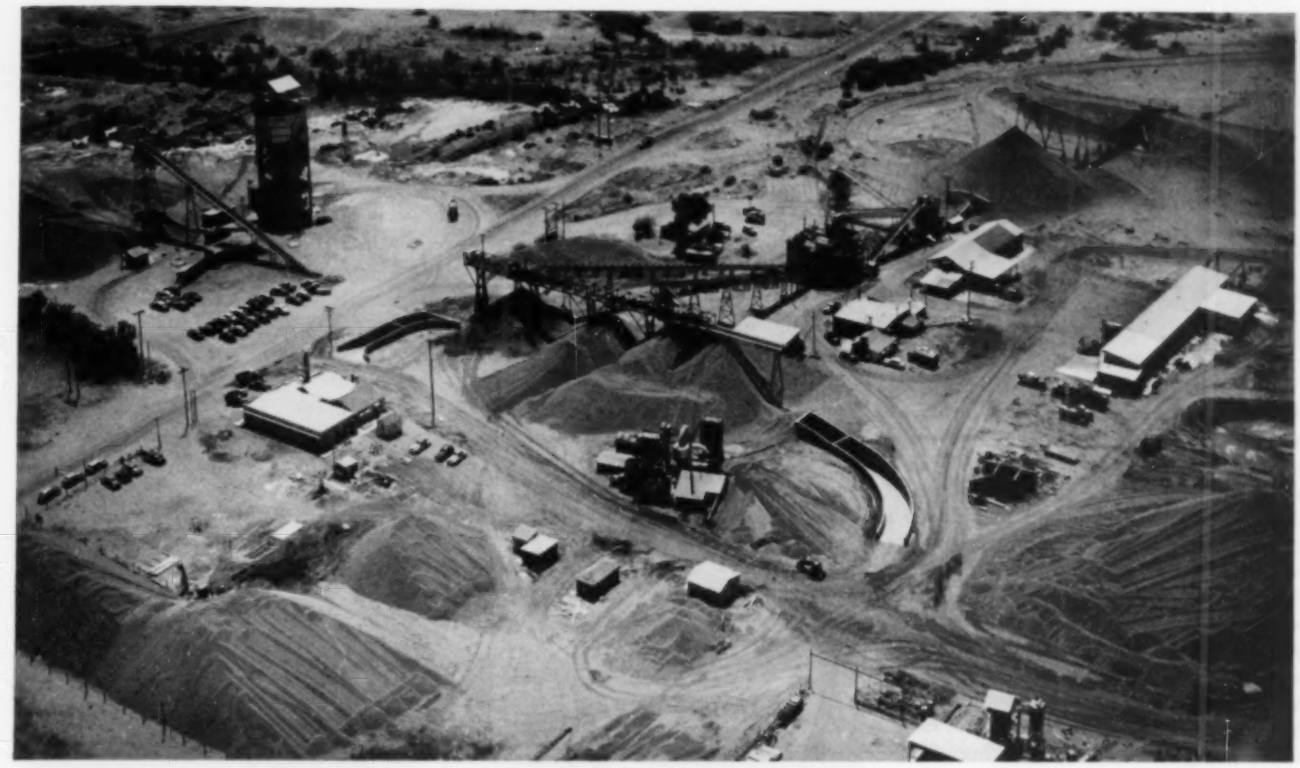
The nation's railroads quickly sensed the advantages of air-operated tampers, and by 1916 the Pennsylvania alone was using 210 of them. Their appearance elicited the following mention in *The New York Times:* "What is probably the most important innovation in track work is the pneumatic tamper now being introduced . . . . Machine tamping costs less than one-third as much as hand tamping, and track tamped with the machine settles approximately one-half as much as track tamped by hand and subjected to the same service."

Various air-powered tools such as spike drivers and rail-bonding drills made their appearance around the same time as tamping outfits, and others had been introduced earlier. All were in great demand during World War I because of the acute labor shortage. Since then other labor-saving pneumatic equipment has been added, and air power now does much of the heavy work in connection with the construction and maintenance of track, bridges, and other essential structures on railroad rights of way.

Thus we find that compressed air has contributed notably to railroad development. For 70 years the air brake and the automatic signal system that were born in the fertile brain of George Westinghouse have safeguarded train operation. From the air-blown converter, devised coevally by Bessemer and Kelly, came most of the steel rails with which pioneer empire builders criss-crossed the continent. In more recent years, railroad shops and track gangs have come to rely heavily upon the time-and-money-saving services of pneumatic tools, which are increasing in variety and numbers all the while.

50-YEAR-OLD TIE

A tie on the original Union Pacific line across Sherman Summit in Wyoming, abandoned nearly half a century ago. The narrow (4½-inch) rail, secured only by spikes, rested directly on the tie and in the deep cut. The resultant brooming and shattering of the wood is evident. Ties are now protected by laying rails on plates that distribute the load and pounding effect of traffic.



THE PLANT FROM THE AIR

This aerial view of the Arizona Sand & Rock Company serves almost as a graphic flow sheet of the operations. At the upper-right, river-run gravel is delivered to a tilting grizzly where oversize boulders are automatically eliminated. A conveyor from a crusher underneath the grizzly feeds the surge pile. From the latter some of the material may go to a secondary crusher and a set of jigs, but all of it passes through a washing plant and then moves, via two inclined conveyors in the center of the picture, to a 7000-square-yard storage area. There a cross conveyor distributes it to piles according to grade and size. Below and at the right of the piles is one entrance to the 400-foot loading tunnel that houses a conveyor belt for transporting sand and aggregates to the concrete mixing tower at the upper left. In the center-foreground is the plant where bituminous hot mixes are prepared for paving roads, and left of it are the general offices. Buildings near the right edge include machine, paint, tire, and general work shops.

Air Power on the Sand Pile

John L. Parker

THE sand and gravel business has progressed a long way since the days when it was the custom to go down to the river bed and shovel on a load. And nowhere has it progressed farther or better than at the plant of the Arizona Sand & Rock Company in Phoenix, Ariz. There Don Kelley, founder of the concern, and his able crew have brought the art of blending sand, gravel, and cement into superior concrete to a fine point. Their equipment consists of a skyscraper concrete mixing tower and of a number of other remarkable innovations including a tilting grizzly, the first of its kind in the rock-crushing business.

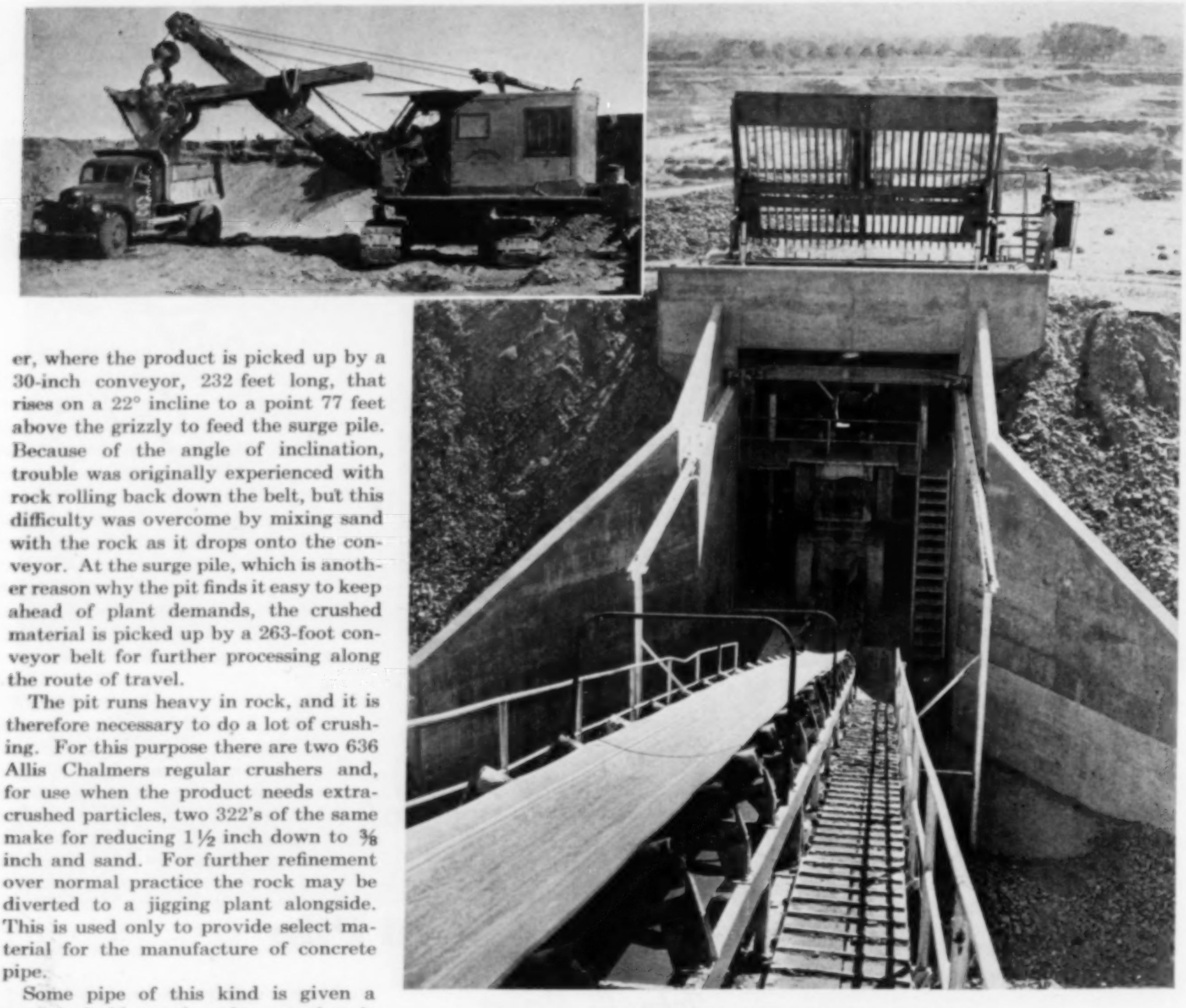
Paradoxically, the more concrete is mixed in the huge plant just at the edge of Phoenix, the less work is done. It is all accomplished with air power, and much of it by remote control. Air power, the management has found, is just as useful in a sand and gravel plant as it is in military strategy. Only the kind of air power that is relied upon there for all the heavy work is supplied by a dependable Ingersoll-Rand Type 40 compressor and is piped to every part of the sprawling establishment.

Air power begins to lighten the job of handling, repeatedly, from 700 to 800 tons of gravel every day almost as soon as it is dug by busy power shovels in open pits on 1700 acres of gravel bed the company has stretching over the dry bottom of Salt River. After the material has been excavated by either a Marion or a Northwest shovel, each of which is equipped with a 1½-cubic-yard American manganese renewable-lip dipper and loads into White 14-cubic-yard dump trucks for a short haul to the head of a surge system, it is dropped on the tilting grizzly, a truly amazing piece of equipment.

The grizzly does exactly what it was intended to do when designed and built in the company shop by Al Carter, plant superintendent, who has been with Kelley for twenty years. It has eliminated Saturday overtime in the pit; the crew now digs enough gravel in five days with the same machinery to keep the place operating six days a week. It has also done away with the back-breaking work of hand-moving heavy boulders.

The grizzly has a simple one-man control, just like the air hoist on a grease rack. A truck drives right on it, dumps its load, and moves on. After it drives off, the worker in charge starts a pump, driven by a 30-hp. motor, to operate two hydraulic hoists that raise one end of the grizzly slowly, allowing time for undersize to slip between the 6-inch spacing of the bars. Boulders fall through a short vee chute into an old dump truck salvaged for the job. The grizzly drops back into position at the end of its arc, and the control man has time to push the load down around the edge of the hopper before the next one arrives.

From the hopper the material is delivered by a 36-inch belt feeder to a 15x36-inch Diamond Iron Works jaw crush-



GRAVEL PIT AND TILTING GRIZZLY

Pit-run gravel loaded by 1½ cubic-yard shovels (upper left) is delivered to a tilting grizzly (above). Undersize material passes through the bars, after which the grizzly is raised to the position in which it is shown and in which boulders too large to go through are dumped into a truck. The gravel falls into a hopper that feeds the jaw crusher, which is not visible. Note the beam built across the upper part of the opening to support a crane that facilitates crusher repairs. The product of the crusher travels on the inclined belt in the foreground to the surge pile.

er, where the product is picked up by a 30-inch conveyor, 232 feet long, that rises on a 22° incline to a point 77 feet above the grizzly to feed the surge pile. Because of the angle of inclination, trouble was originally experienced with rock rolling back down the belt, but this difficulty was overcome by mixing sand with the rock as it drops onto the conveyor. At the surge pile, which is another reason why the pit finds it easy to keep ahead of plant demands, the crushed material is picked up by a 263-foot conveyor belt for further processing along the route of travel.

The pit runs heavy in rock, and it is therefore necessary to do a lot of crushing. For this purpose there are two 636 Allis Chalmers regular crushers and, for use when the product needs extra-crushed particles, two 322's of the same make for reducing 1½ inch down to ⅜ inch and sand. For further refinement over normal practice the rock may be diverted to a jigging plant alongside. This is used only to provide select material for the manufacture of concrete pipe.

Some pipe of this kind is given a smooth inside surface by rotating it while still wet against a stationary blade. To do this successfully it is necessary that the gravel in the concrete mix be of uniform density, otherwise the lighter aggregate will float to the surface and make it impossible to trim the pipe. The jigs were built in the plant shop. Generally, however, gravel is taken from the surge pile and carried to a washing plant where it is separated from the sand by a combination of screens and drags to produce the various grades of sand and rock, aggregate for concrete, and material for making asphalt in its large bituminous hot-mix plant for road and street paving.

Arizona Sand & Rock has eighteen mixer trucks, six dump trucks for transporting sand and gravel, and ten pickups and two 14-cubic-yard 10-wheel diesels for hauling gravel from the pit. The company, like many other heavy-material handlers, has found that tire costs can mean the difference between profit and loss on some jobs. It has a weekly inspection program, and tires on all equipment are also checked every morning beginning at 4 a.m. As a result of this service, pneumatic tires have been successfully recapped as many as three times.

Recently, the company took a leaf out of the book of the meat-packing industry, which "saves everything but the squeal," by installing a scavenger wash that catches the water from all the other sand drags and puts it through a final cleaning. This inexpensive addition, made of old odds and ends and powered by a 7½-hp. General Electric gearhead motor with an auxiliary gear box to lower the speed, reclaims from 60 to 100 tons of sand daily and helps in grading concrete sand.

As the material comes from the pit and passes through the plant it is given a complete laboratory check several times daily. Two high-speed conveyors transport the sand and crushed rock to 7000-square-yard surface storage of which 40 percent is live storage. There they are piled according to grade and size by a cross conveyor with a number of side gates. The area is tapped by a 400-foot combination truck and conveyor tunnel which has 24 overhead gates—twelve for truck- and the same number for belt-loading. All are opened and closed by air-powered cylinders actuated by electric buttons. The truck gates are opened in the tunnel, while those over the conveyor can be operated there or by remote control from the nearby premix tower. The belt is made up of three sections and carries sand and aggregate to storage bins on the upper level of the 115-foot-high tower, a total haul of 750 feet.

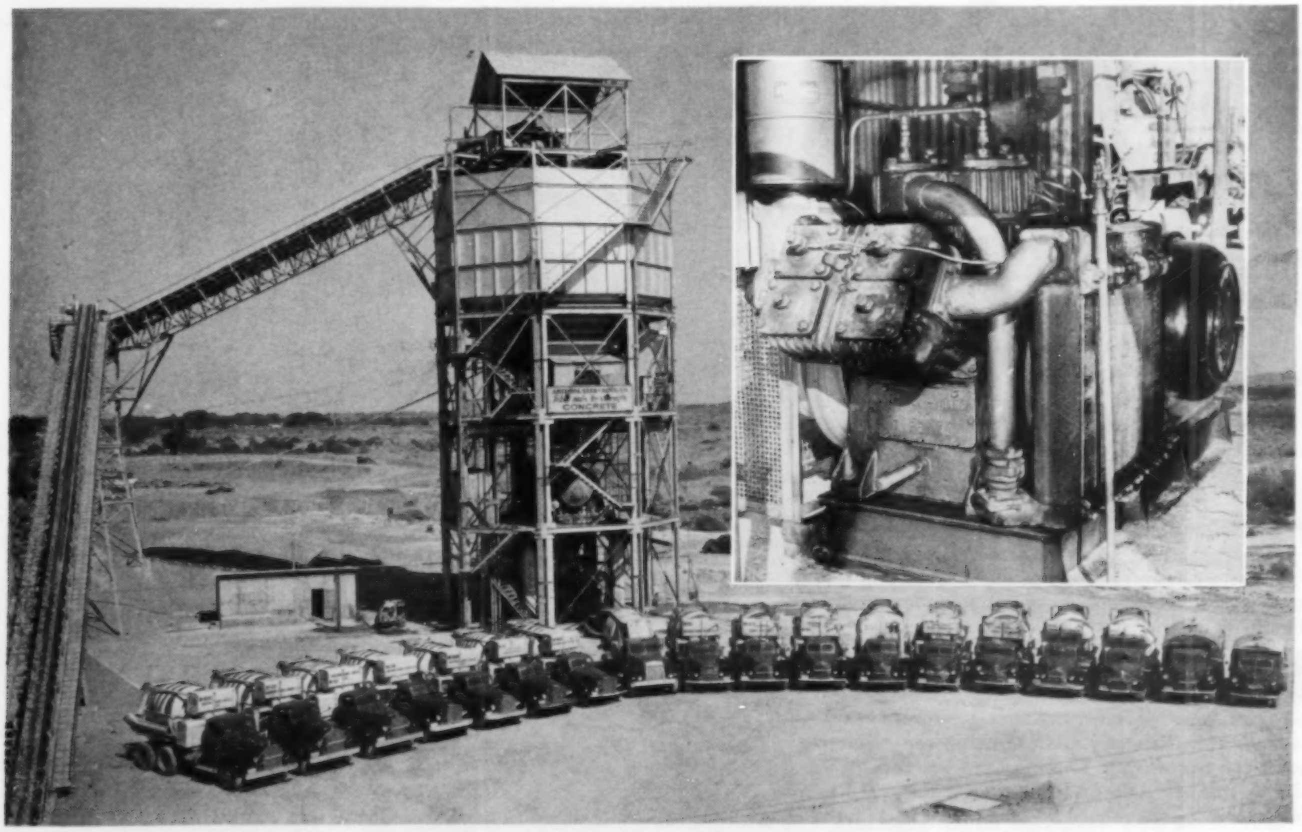
The tower is a fine example of modern means of mixing concrete. It is one of a few in the country and does excellent work. Most concrete that is sold ready mixed for delivery on the job is made by pouring the dry ingredients into trucks, adding water, and mixing the batch in transit. This method has two important disadvantages—the trucks cannot carry a full load, and there is no accurate control over mixing.

In the Arizona Sand & Rock premixing tower compressed air really goes to work. It juggles the big mixers, supplies the conveyor belt with the desired product, performs miracles of exact weighing by instantaneously shutting gates, and even transmits orders to the control room. In the center of the ring of sand and gravel bins at the top of the big 4-story structure is a bin with a storage capacity of three carloads of bulk cement that is hoisted by a Palmer Bee bucket elevator. At this level are the push-button controls which open and close the conveyor gates in the tunnel. The gates are on a constant light to show their positions. On the third floor are the plant's testing laboratory, the control room, and the automatic batch-weighing scales.

As a ready-mix truck comes in, the driver stops at the dispatcher's office before loading. There he gets a ticket, one copy of which is put in a pneumatic tube that carries it to the control-room operator. The latter reads it, sets a series of levers, and the air, controlled by electric circuits, does the rest. The pneumatic gates of the various bins open, and sand, gravel, and cement are weighed simultaneously on a Hardy automatic weigher, the largest set ever made on the Pacific Coast. The scales drop the properly proportioned batch into a hopper provided with an air-powered revolving nozzle that feeds it into one of two Koehring 4-cubic-yard concentric tilting mixers on the second level. A jet of air directed around the edge of the hopper after it has discharged its load insures complete delivery of the dry batch into the Koehring. The water required is pumped from the company's own wells and is metered into a large tank from which it is dumped into the mixer.

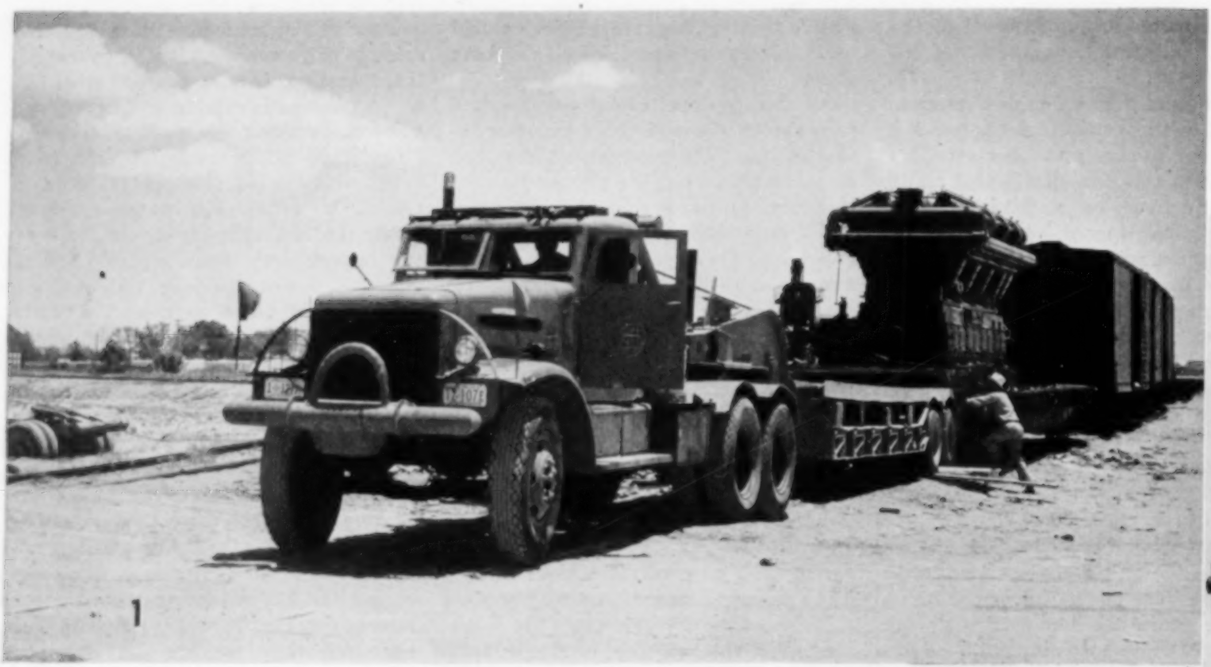
After the mixers have completed their job of making concrete of the right consistency, which is nicely computed on registering instruments showing the amount of power used in the course of the operation, they are turned over by heavy pneumatic cylinders while still revolving, dumping the ready-mix into a funnel-type hopper with an air gate actuated either from the control room or the loading ramp. The control operator forces the wet, clinging concrete out of the hopper and cleans up around its edges by means of a long, flat, nozzled pipe attached to an air hose, the blasts leaving it as clean as though it had been washed.

The ground floor of the tower is the loading ramp for the premix trucks that take on up to 8 cubic yards of material. It also houses the hardest-working piece of equipment in the plant, according to Al Carter, who has unbounded admiration for the sturdy and dependable Type 40 air compressor. This air-cooled unit has run fourteen and sixteen hours a day for the past three years with time out only for one set of rings. For several months of the year, Phoenix has an average temperature of 100°F. Because high temperatures are a bit rough on machines of this type, the performance speaks well for the design and construction of the compressor.



CONCRETE MIXING TOWER AND COMPRESSOR

In the 4-story tower, just about everything that responds to push-button controls is done with air power. The concrete prepared in two 4-cubic-yard mixers is delivered to users throughout the Phoenix area by the eighteen mixer trucks shown in the foreground. In the inset is the Ingersoll-Rand Type 40 air-cooled compressor which has run 14-16 hours a day for three years with only minor repairs despite an average summer temperature of 100°F.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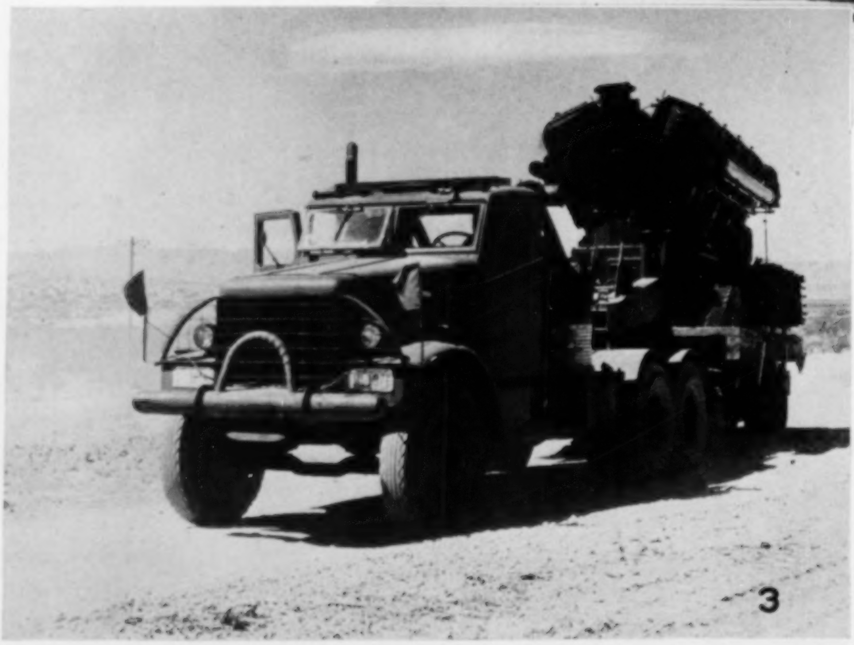
On the Road to Guadalupe

Illustrations and information from
El Paso Natural Gas Company

Drawing reproduced from cover of "The Pipeliner," employee publication of El Paso Natural Gas Company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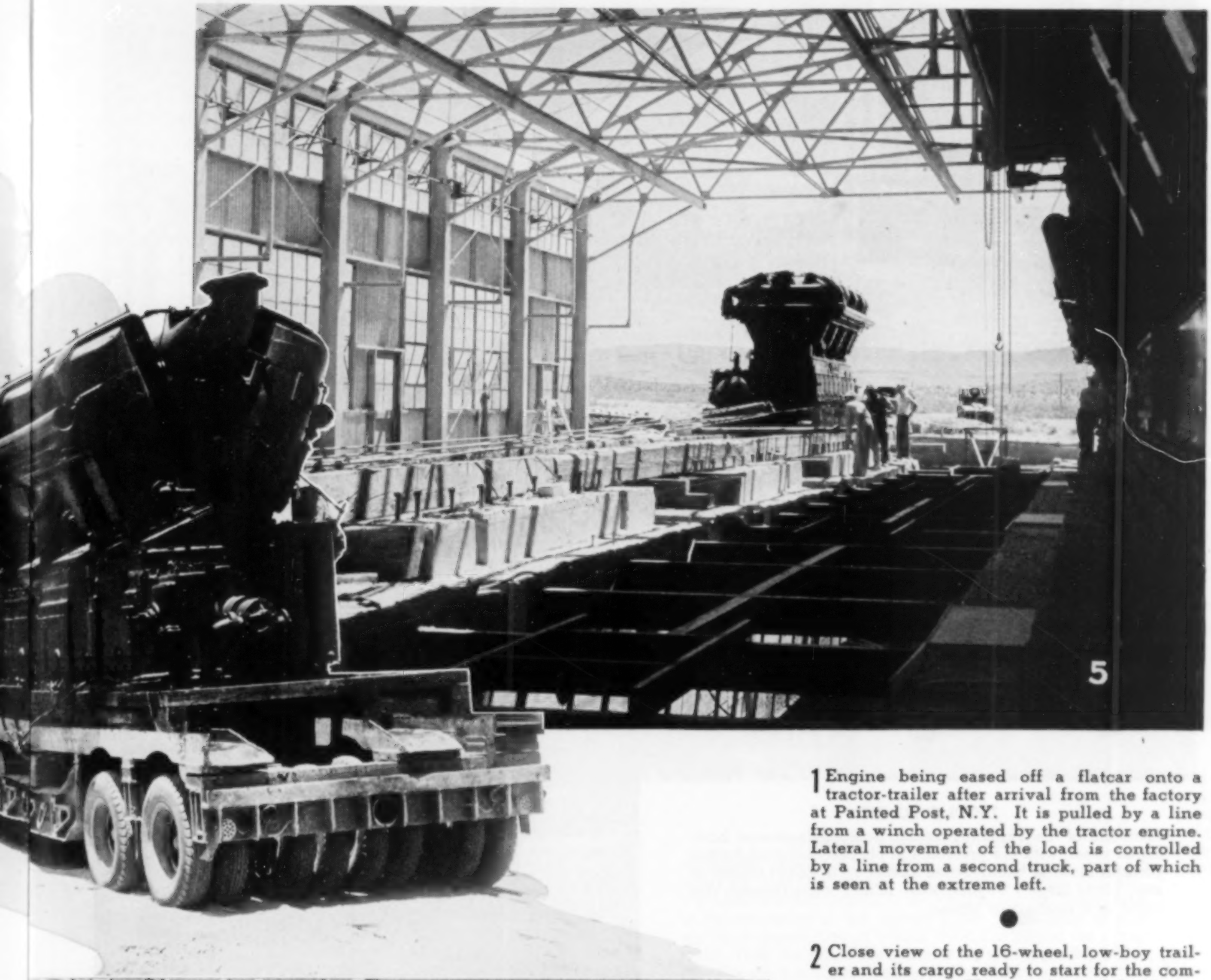
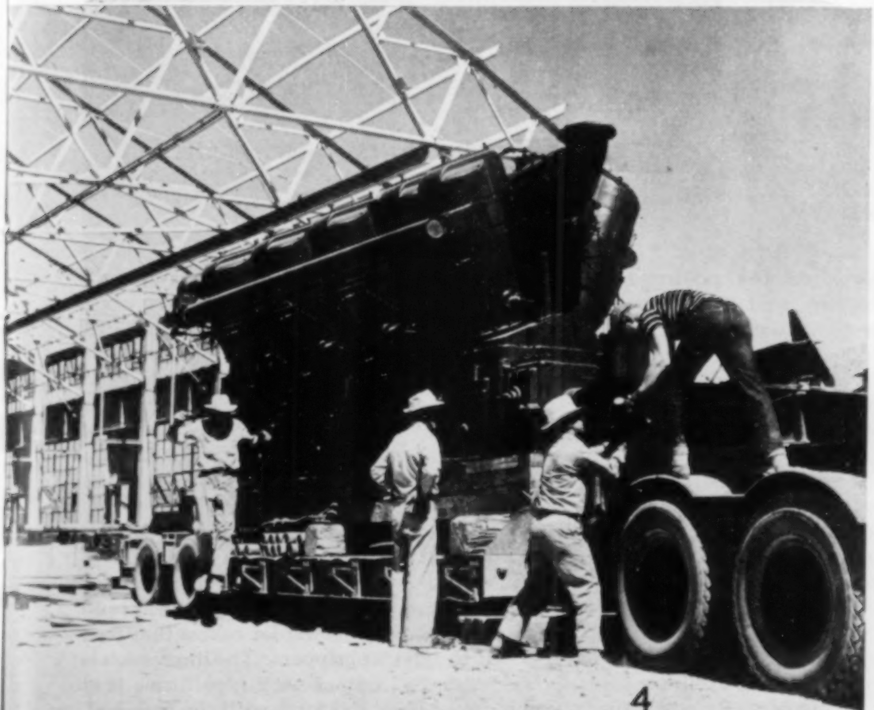
THE average industrial plant is situated on or close to a railroad and therefore experiences comparatively little difficulty in having heavy machinery delivered. A natural-gas transmission pipe line, on the other hand, generally follows the shortest route between its terminals. Compressor stations for boosting gas pressure are often in remote spots. Getting construction materials and equipment to them frequently requires building long stretches of access road and the employment of heavy-duty automotive haulage units for the transportation of the thousand-and-one items that enter into them.

El Paso Natural Gas Company recently put into service 1000 miles of 24- and 26-inch line to deliver natural gas from Dumas, in the Texas Panhandle, to the Colorado River for delivery to the Los Angeles, Calif., area. Its Guadalupe, Tex., compressor station is 95 miles east of El Paso, and all of the materials for it were trucked that distance. These pictures show steps in the transportation of a piece of machinery weighing 105,000 pounds. It is the engine for an Ingersoll-Rand 1000-hp. KVG compressor. Nineteen of these units have so far been installed in the Guadalupe plant. Flywheels and compression cylinders were hauled separately and put on the engines after the latter were set up.





1 Engine being eased off a flatcar onto a tractor-trailer after arrival from the factory at Painted Post, N.Y. It is pulled by a line from a winch operated by the tractor engine. Lateral movement of the load is controlled by a line from a second truck, part of which is seen at the extreme left.

●

2 Close view of the 16-wheel, low-boy trailer and its cargo ready to start for the compressor station. The winch used for transferring it from the flatcar is shown just behind the truck cab. This haulage equipment is owned by El Paso Natural Gas Company.

●

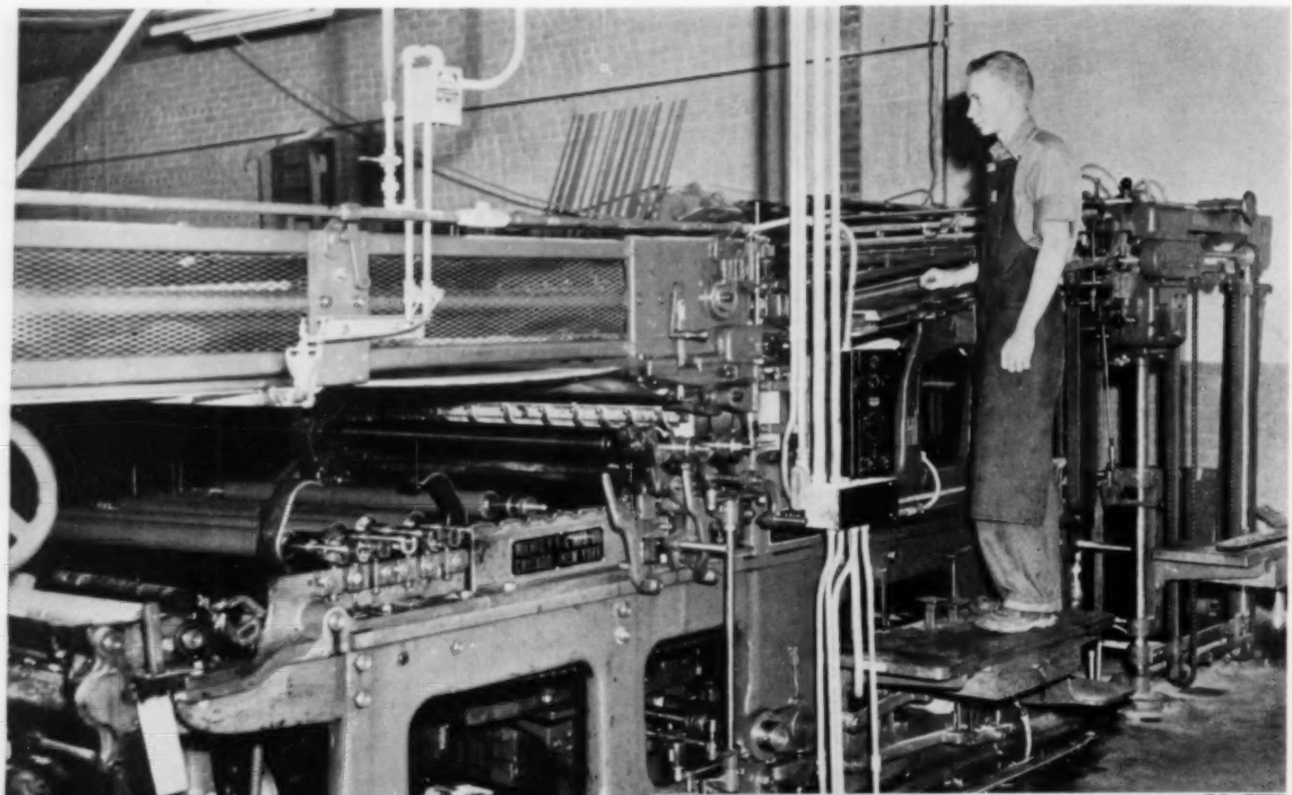
3 The first 80 miles was smooth going on U.S. Highway 62. Then the White diesel-powered unit turned off on a dirt road, as shown here. This road was built by the company, which also maintains it.

●

4 Upon arrival at the compressor station the tractor backs the trailer up to the end of the partially completed building. Chocks are placed to prevent the wheels from moving so that the tractor can be uncoupled and run to the opposite end of the station. A jack is being handed down for use in helping to anchor the trailer securely.

●

5 Journey's end. Again using power from the tractor winch, the engine is slowly pulled off the trailer and along a timber trackway to its operating position. There it was set on a concrete base, accurately leveled, grouted firmly in place, and its compression cylinders, flywheel, and other accessories assembled on it. Visible at the extreme right is part of a row of machines that were previously erected.



LITTLE TO DO
Rear end of the Valliant Printing Company's newest horizontal press, with the pressman at his post, his push-button controls close at hand. Paper sheets up to 28x41 inches in size, borne largely by pneumatic hands, move through this robot in a continuous stream.

VALLIANT PRINTING COMPANY PLANT
This establishment in Albuquerque, N. Mex., prints several magazines and turns out a wide variety of miscellaneous smaller forms ranging from cards to folders.

Pneumatic Fingers Speed Printing

Fremont Kutnewsky

YOUR daily newspaper hits the street and also your front door with news so hot it fairly sizzles. You, the reader, demand that and are annoyed if your "daily" is delayed an hour. Such high-speed handling of news is possible because of automatic presses that print from a continuous roll instead of a pile of separate sheets.

But job printing is different. Your letterheads are of one size, the other fellow's circulars are of another, and in between are announcement cards, invoices, booklets, and catalogues, to list only a few. Each has to be handled individually; there is no chance of continuous roll printing. One of the traditional bottlenecks in getting out all this miscellaneous printed matter as fast as businessmen want it has been the hand feeding of presses. But this is on the way out since the introduction of automatic machines equipped with feeders that do the work by means of compressed air and suction.

In pressroom parlance, automatic often means compressed air and vacuum, for they do a great deal more in a modern print shop than feed paper. The Valliant Printing Company of Albuquerque, N. Mex., has recently set up a new Miehle 41 automatic press and is just one of thousands of plants in the United States where compressed air is used in every department. It blows dust out of linotype machines, cleans type, and operates guns that spray a solution or powder on printed sheets as they come from the presses in order to prevent offset.

The big machine is fascinating to watch. Curved rubber tubes serve as feeders. They look like the tentacles of a dancing "devil fish," looping up from a central point and branching out across the width of the sheet about to be printed. Six of the tubes have suction cups at the ends: two pick up the sheets one at a time, and the four others, at just the right instant, take over and carry each to forwarder rollers that feed it to cylinder grippers. The impression is made by contact with type forms that travel back and forth with the pressbed.

The cylinder makes two revolutions to print one sheet.

There are six more tubes. These are at the rear of the press and blow air through metal mouthpieces at the back edge of the stacked sheets of paper in the feeder. First they "feather up" the edges of the top sheet. Then they blow a jet of air beneath it as the rubber suction cups above take hold. For a split second it is in level suspension before moving forward straight and true into the feed rolls. This is exactly what a human press feeder does, only slower and not so well. He picks up the top sheet, gives it a little whip to get the air under it, and floats it into the grippers.

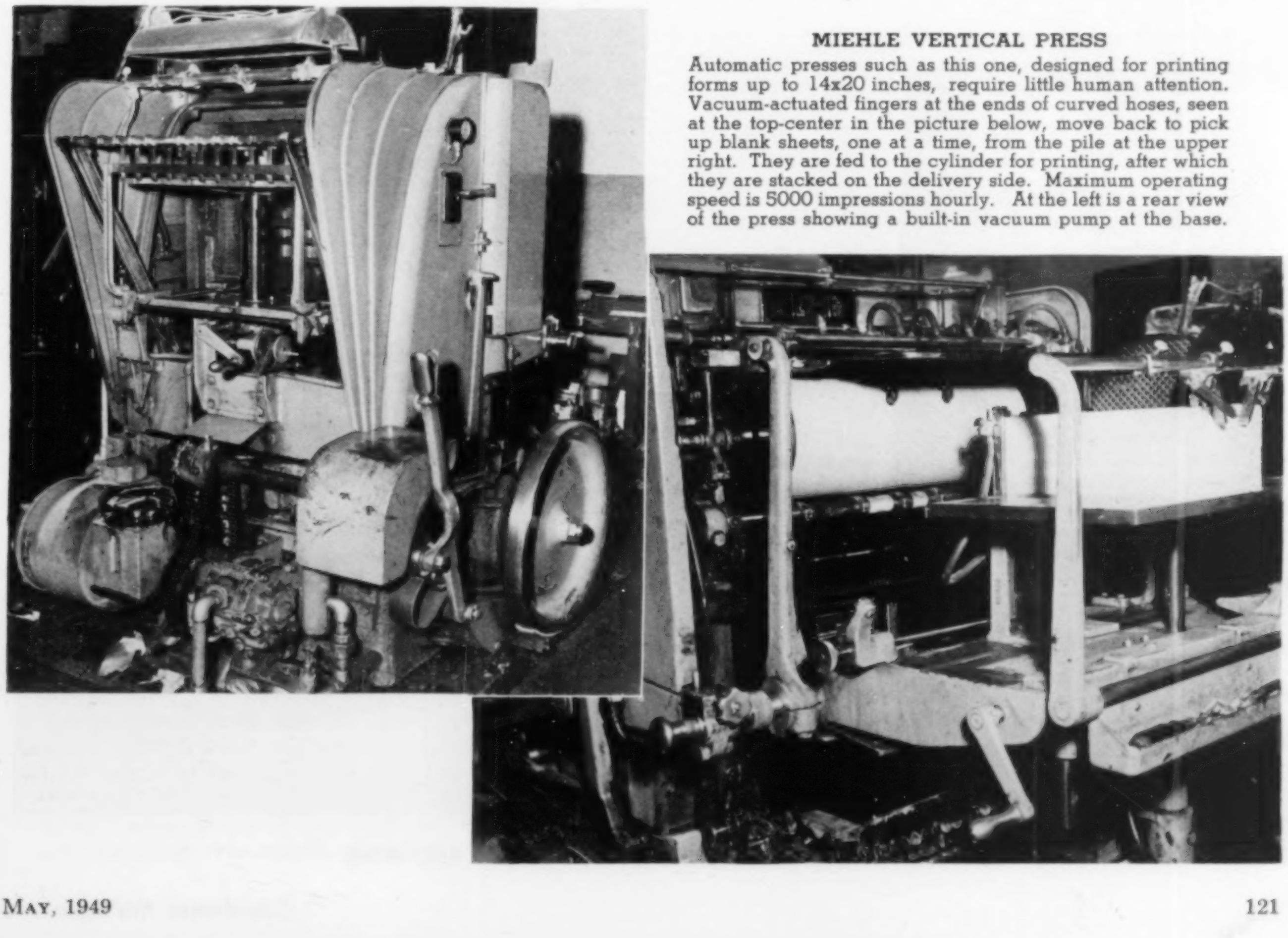
Towards the front end of the press, where the printed paper comes off the cylinder, compressed air has more work to do. Seized by grippers on an endless chain, the sheet is carried on its way to the delivery pile under a blast of air that sprays a powder on the freshly printed surface. This prevents offset; that is, the transfer of ink from one sheet to another deposited on top of it. Immediately thereafter the paper passes over a row of gas flames which remove static electricity generated by the movement of the press. If that were not done the printed sheets would cling together. Static has been the bane of pressmen ever since high-speed printing became practical. It makes the sheets hard to handle during folding and can be the cause of ruinous offsetting.

But even with no static, the paper may still buckle and curl in dropping from the machine on to the stack. So compressed air again comes to the rescue. Right at the end of the chain delivery, each sheet goes over a series of metal rollers in which are suction holes. The rapidly moving paper hugs these rollers tight, and to make sure that it does, a jet of air plays on it from above. As a result, it is deposited gently on the delivery pile just as though human hands had grasped both ends and carried it there. Because pneumatic control is unerring, the big press will print sheets of such thinness that a human press feeder could hardly handle them. The tendency of paper to billow and buckle is positively checked all the way through by suction and by blowing.

The new Miehle has two built-in air compressors of 1 hp. and 2 hp., respectively, and vacuum is induced by making connections with the intake sides of these units. In addition, air for miscellaneous uses is piped throughout the Valliant shop from a 1½-hp. unit in the basement. The large press does about everything but think; it not only feeds itself but does the work twice as fast and with greater accuracy than the most skilled pressman could do it. An experienced operator can handle about 1500 sheets an hour, whereas the machine turns out 3000 printed sheets an hour with ease. Because of this speed, the feeder holds as many as 25,000 sheets measuring 28x41 inches. A sheet of this size, printed on both sides, makes up sixteen pages in a magazine like this one.

Smaller presses such as Miehle verticals and the Kluge automatic also are equipped with suction feeders; and the former, like the Miehle 41, have built-in compressors. The verticals accommodate sheets or cards ranging in size from 3¼x5½ to 14x20 inches and therefore handle a wide variety of jobs. They have a rated maximum speed of 5000 impressions per hour, or more than 83 per minute.

Many ingenious mechanical feeders that work well were developed before the advent of suction feeding, but it is significant to note that nearly all the newer presses are equipped with feeders of the latter type. Until the Valliant Company installed the Miehle 41, the pressroom was a bottleneck. The plant prints the New Mexico State magazine, a fishing and hunting journal, several house organs, and numerous booklets and folders for the state's tourist bureau that involve long runs. The big press has doubled the shop's capacity and enables it not only to turn out the various publications on time but to handle other routine jobs as well.



MIEHLE VERTICAL PRESS

Automatic presses such as this one, designed for printing forms up to 14x20 inches, require little human attention. Vacuum-actuated fingers at the ends of curved hoses, seen at the top-center in the picture below, move back to pick up blank sheets, one at a time, from the pile at the upper right. They are fed to the cylinder for printing, after which they are stacked on the delivery side. Maximum operating speed is 5000 impressions hourly. At the left is a rear view of the press showing a built-in vacuum pump at the base.

A History Book of Stone

A STONE monument on the campus of Pennsylvania State College encompasses millions of years of natural history. To the layman it is only an attractive, 4-sided, slightly tapering obelisk, but to a geologist it is a record of the ages. This unusual column is 33 feet high and contains 281 blocks of building stone taken from many different formations and gathered from 139 localities, mostly in Pennsylvania. They are arranged in the order of their geological occurrence, with the oldest ones at the bottom.

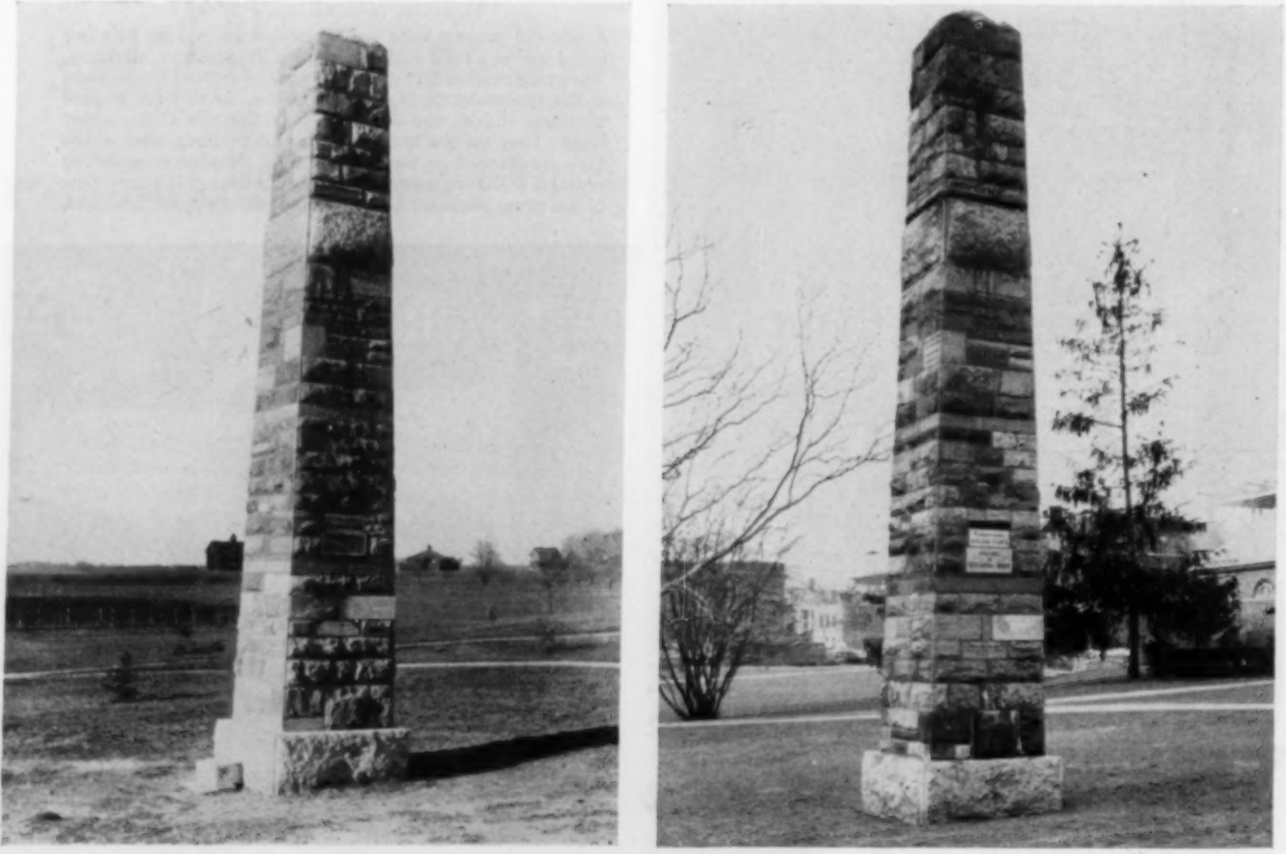
The polylith was erected in 1896 at the suggestion of Dr. Magnus C. Ihlseng, Penn State's first professor of mining engineering and geology. He visualized two uses for it: an aid in teaching geology and a display of stones for the guidance of builders. On the latter score he reported to the president of the school: "It exhibits many of the varieties of structural material with which Pennsylvania is endowed and reveals to the architect at a glance the possibilities of artistic combinations with our native products. To the builder similar information is given, together with that afforded by the reports of the physical tests and microscopic examination of its constituent specimens."

As his thesis for a B. S. degree, William L. Affelder, of the Class of 1899, made the microscopic examinations and also compiled information on the type of each stone, its geologic age, its position in the polylith, its donor and origin, and an estimate of its worth as a building material. The thesis has reposed in the school's library for 50 years. It was recently brought out and studied by John Eliot Allen, associate professor of geology, who used the data to make a chart embodying the essential information. At the same time he examined the blocks to see how each had been affected by a half century of weathering. Then he reviewed Affelder's appraisals as to the suitability of each variety for building purposes and made a few changes. For the most part, however, the 1899 estimates seem to have been corroborated by the passing years.

The obelisk has been on the campus so long that it is an old story there and has consequently received little publicity of late. Attention was drawn to it a few months ago when the college received a letter from one of its graduates, William C. B. Alexander, a Washington, D. C., engineer, who had a part in the monument's construction. He recalled that in 1894, after finishing his freshman year in the new course in mining, he was employed as Doctor Ihlseng's secretary and assistant to procure stones for the structure.

"Letters explaining the proposition and soliciting specimen building stones," Alexander wrote, "were sent to Pennsylvania quarry operators and others who were interested. As some inducement, prospects were given the privilege of cutting their names in the faces of the stones they donated. The idea created much interest among quarrymen and builders. The response and assistance were generous." In the course of that summer he toured central Pennsylvania on a bicycle collecting specimens. It took two years to obtain the 281 blocks, and the polylith was built in 1896. The placing of the stones in their geologic order was supervised by Prof. Thomas C. Hopkins, then assistant professor of economic geology.

Following the receipt of this history, Professor Allen undertook to bring the information up to date for architects and builders and to assemble the geological data offered by the obelisk in a form more easily usable by beginner-students. Upon the completion of these assignments, he prepared an article on the polylith for *Mineral Industries*, the college's School of Mineral Industries publication. Our information and pictures came from that source.

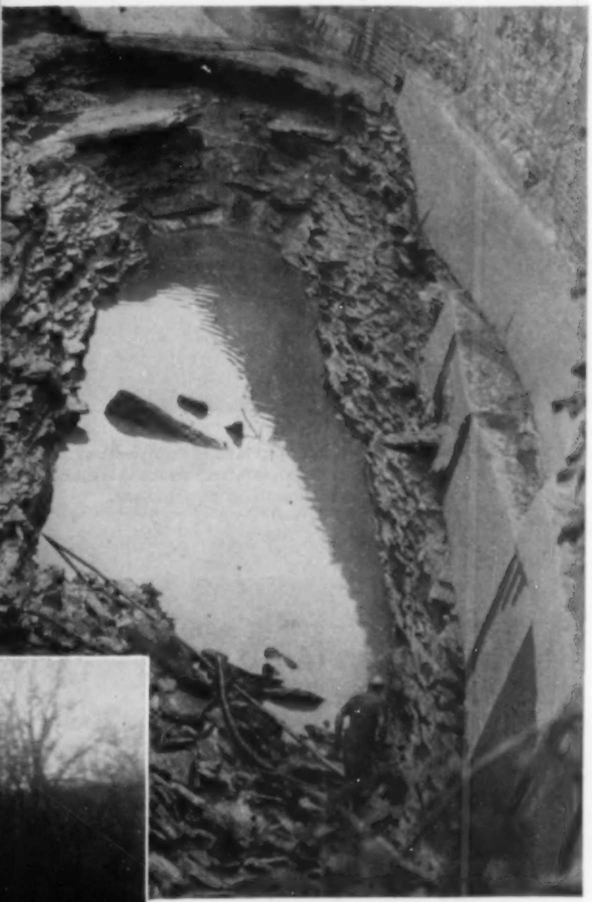


PENN STATE POLYLITH, 50 YEARS AGO AND NOW

Curbing a Rampageous Creek

RUNOFF FROM STORM

Picture at the left shows torrent of water pouring down the canal after only a moderate rain. The heaviest flow is in the spring.



RESULT OF EROSION

Hole dug out by water rushing over spillway shown in view at top-left. After the water had been pumped out and the rotten rock removed from the bottom the depression measured 32 feet deep.

AREA OF OPERATIONS

Double-track line of the Baltimore & Ohio Railroad, with train approaching from the east. The canal is at the right.

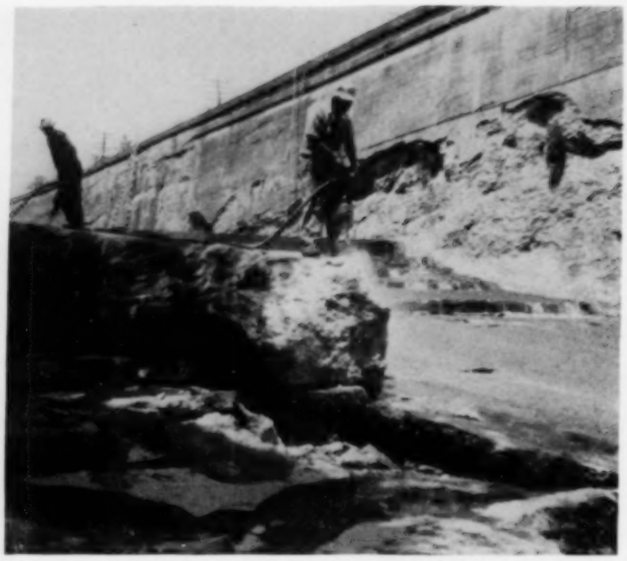
EROSION caused by a stream running alongside the main-line tracks of the Baltimore & Ohio Railroad west of Dillsboro, Ind., had reached such proportions by last year that corrective measures had to be taken. A concrete retaining wall, 400 feet long, and an additional connecting stone wall that had been built when that stretch of the stream was canalized had both suffered damage on occasions when the runoff from storms transformed the waterway into a raging torrent. The canal bed also had been gouged out in several spots, the worst one being just below a spillway where a hole 32 feet deep had been excavated. The bottom of the latter was 68 feet below the top of the retaining wall. As a picture on this page shows, the water had undercut the wall as well as the underpinning that had been placed to support it.

The George E. Detzel Company of Cincinnati, Ohio, which specializes in the restoration of masonry surfaces, was given the job of repairing the damage and reconstructing the canal so as to bring an end to the stream's rampages. The work involved pressure grouting of the stone wall and coating it as well as the concrete section with 3 inches of reinforced Gunite. Depressions in the channel were filled in. To obtain the material required for that purpose, sections of the natural bank on the side opposite the railroad tracks were blasted down, thus widening the waterway. The canal bed was then leveled and paved with concrete to prevent a recurrence of the havoc wrought by erosion.

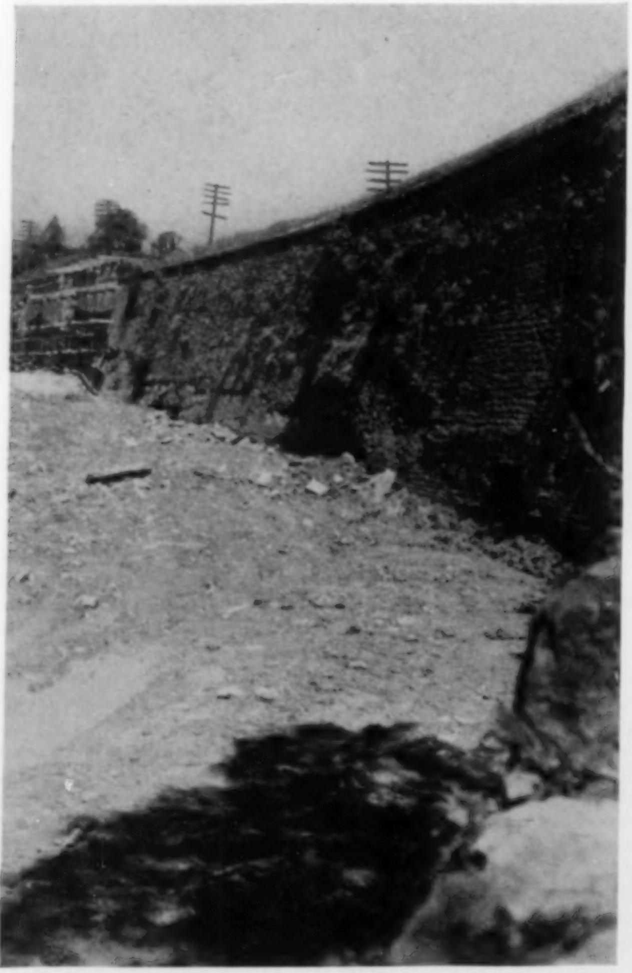
Virtually all the operations involved the use of air power. An Ingersoll-Rand 315-cfm. portable compressor was one of the first pieces of equipment moved in. William T. Smith, general superintendent for the contractor, states that "It would have been almost impossible to excute this job without air tools such as chippers, paving breakers, Jackhamers, and sump pumps, and air motors for operating the Guniting and grouting units."

The pictures on this page were taken before the repairs were made. Those on the two following pages show some of the principal steps in the work of rehabilitation.

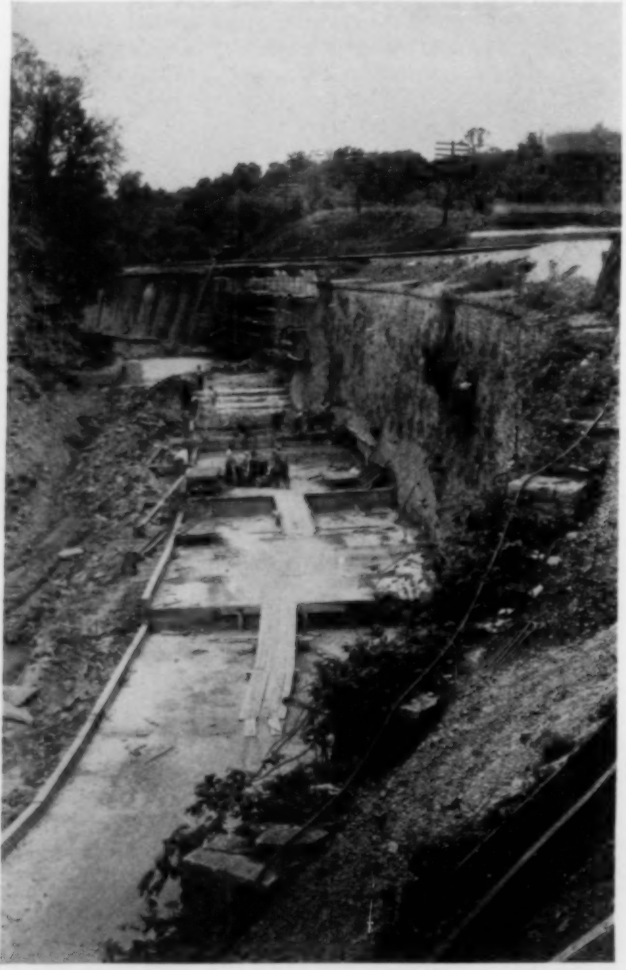
Ingersoll-Rand Mobilair portable compressor being set up to supply power for operating various demolition tools and Guniting and grouting equipment.



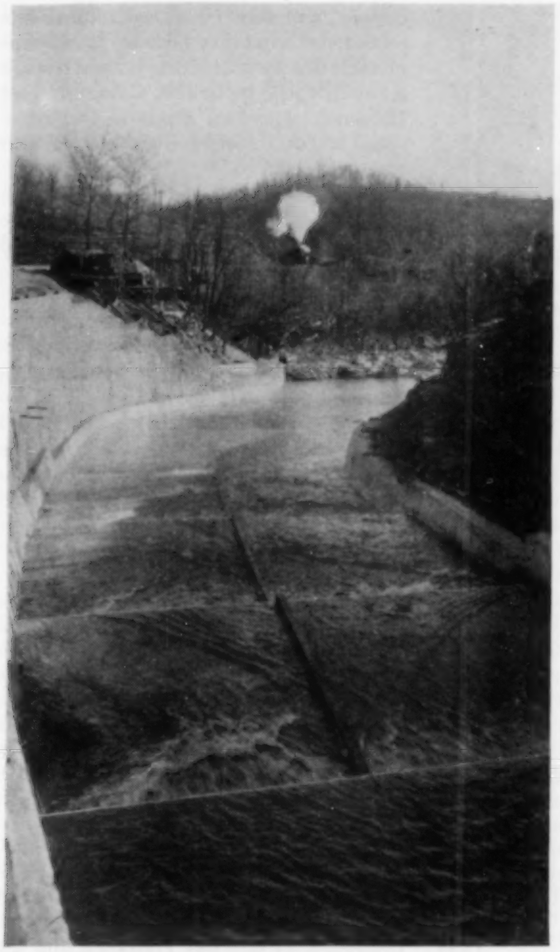
Paving breakers cutting out disintegrated concrete placed in previous efforts to control erosion. Damage done to the base of the wall is visible at the right.



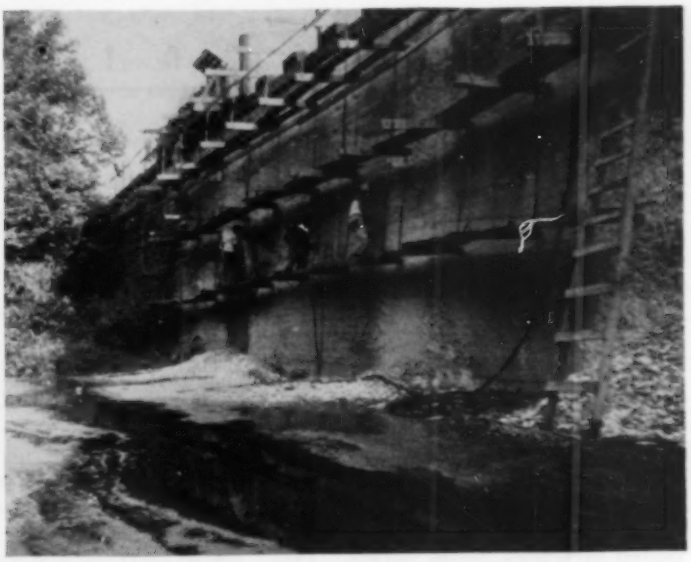
Section of canal bed after left bank had been blasted down to widen the waterway and material been spread over bottom by a bulldozer to fill depressions and to even the surface.



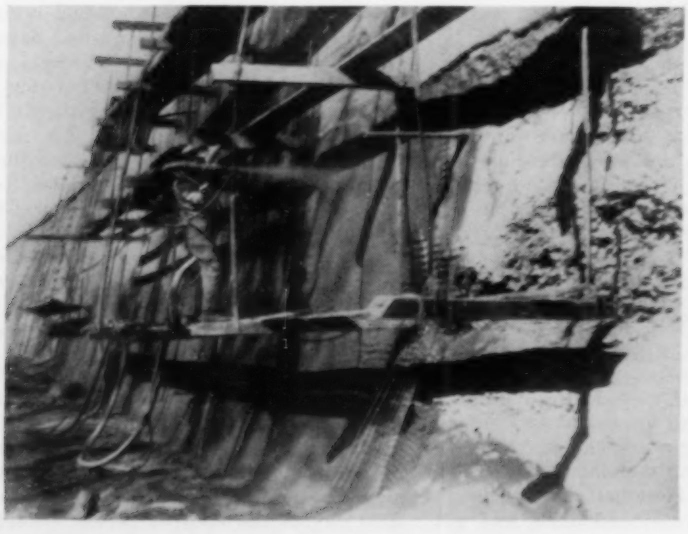
Paving of bottom with reinforced concrete approaching completion. Near section of wall on right is of stone and that at far end of concrete. Tracks are about 35 feet above canal bed.



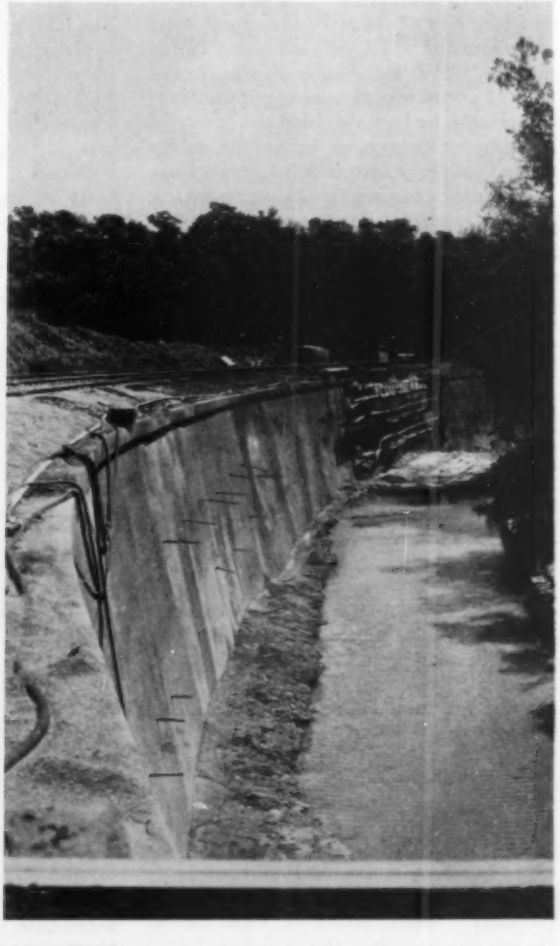
Looking downstream, showing paving and curb walls completed and water flowing down terraced surface. The left half was paved first while the water ran on the right side. The flow was then diverted to the finished section, where it was confined by the low central wall.



Because the job was started in spring and considerable water was flowing, it was decided to repair the concrete wall first. Here workmen are shown cutting out disintegrated sections with paving breakers.

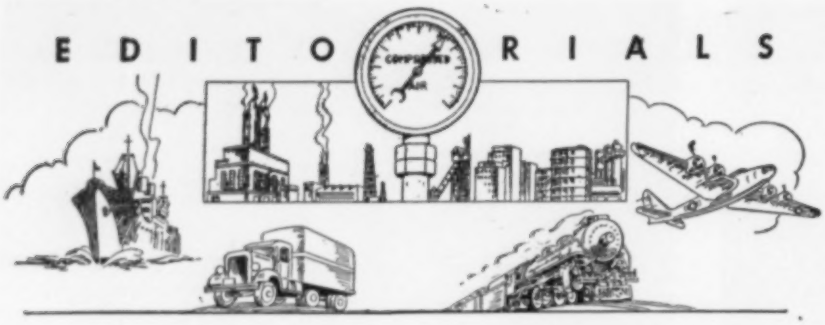


After disintegrated wall sections had been removed and only sound concrete was exposed, mesh reinforcing was secured to the structure and Gunite applied, as shown here.



The rehabilitated concrete wall, with work still in progress on the rock wall beyond it. The projecting weep pipes serve as drains for water accumulating back of the wall.

EDITORIALS



A PROSPECTOR PASSES

TOM CREIGHTON, who had spent most of his 75 years prospecting for minerals in the Canadian hinterlands, died last month. The Canadian press published the fact rather briefly, and in all probability few obituary notices appeared in United States papers. Yet, Tom Creighton initiated one of the most absorbing of mining romances. It was he who made the discovery that has grown into the fabulous Flin Flon Mine of the Hudson Bay Mining & Smelting Company. It was a slow and painful growth, and there might not be a mine there today had it not been for the perspicacity and tenacity of John E. Hammell, long known as one of Canada's leading "mine makers," for it was Hammell who, in the face of recurring discouragements, persisted until he had obtained the financial backing necessary to bring the oddly named property into fruitful production.

How the mine acquired that name is a story in itself. It has been said that the oriental-sounding title was borrowed from an early-day Chinese cook who worked there, but that is not true. Actually, while Tom Creighton and five companions were roaming northern Manitoba in 1914, alternately prospecting and trapping, they picked up a paper-backed novel in a deserted cabin. That was a rare find, as reading matter was at a premium. The book was called *The Sunless City*, and told of an underground domain in which gold was so plentiful that nobody bothered to pick it up. The author, J. E. P. Muddock, assured his readers that the fantastic story was based on the papers and diaries of one Josiah Flintabbatey Flonatin, Esq., an American citizen. The novel was read and reread by the six bushmen, but as the final chapters were missing they never knew how it ended and used to speculate on what finally happened to old "Flin Flon," as they nicknamed him.

While Creighton was out alone one winter day he saw moose tracks in the snow in the vicinity of Phantom Lake and his thoughts instantly turned to the pleasant contemplation of fresh meat. He set out to follow the trail but didn't get far. It led him to a wind-swept area near a small lake where exposed rock was studded with copper pyrite. He forgot about the moose, chipped off samples of the ore, and returned with them to his companions. Previously they had found small showings of gold, and at the moment one of their number, Dan Mosher, had absented himself on a trip back to civilization. Unknown to them he had visited Hammell in Toronto and, on the strength of the gold samples, obtained some supplies from Hammell and two associates in return for a half interest in whatever the sextet might find.

Returning north, Mosher broke the news to his companions. By that time winter snows were gone, and Creighton's find had been examined more carefully. The heavily mineralized rock ran out into the small lake and disappeared under the water. Jokingly, the prospectors said that that must have been the place where Flin Flon came up from his sunless city and shook the metal from his whiskers. Promptly they named the body of water Flin Flon Lake. They staked numerous claims; the first one by Creighton on August 15, 1915, was called the Unique because the outcrop was just that. None of the claims was christened Flin Flon, but a board sign reading "Flon Flon Mine" was nailed to a tree to identify the entire group. It was there when Hammell unexpectedly made his appearance at the Phantom Lake camp.

With his wife, the promoter had portaged their canoe seventeen times to reach the remote area. They were bent on a fishing trip, and it was not until they had carried out that intention that Hammell would look at the Flin Flon stakings. His experienced eye saw the possibility of extensive mineralization, but it also told him that much money would be needed for adequate exploration. Returning south with samples he got in touch with Hayden, Stone & Company, Boston and New York capitalists, who had brought some of the American porphyry-copper deposits into production. They were impressed and agreed to send in engineers loaned them by Daniel Jackling, eminent American mining expert. Hammell assembled supplies and two diamond drills and got them into Flin Flon before the spring break-up. Detailed prospecting, begun in March, 1916, revealed a huge deposit of a complex ore containing silver, gold, copper, and zinc. The last named was considered a liability because there were no facilities for extracting it from the ore short of those in British Columbia and Belgium. Hayden, Stone & Company spent $50,000, pondered the matter, and then withdrew.

Then Hammell started over again. This time he got backing from Dave Fasken of Haileybury, Ontario, who formed the Great Sulphide Company to develop the property. Once more Hammell got supplies together and transported them over the snow in horse-drawn sleighs. Drilling was resumed in March, 1917, and showed that the deposit was even larger than it was believed to be. But the backers decided that the ore was too complex to be profitably treated in that out-of-the-way place and bowed out, retaining a 35 percent interest for the money they had expended.

Now, armed with additional engineering data, Hammell interested the Mining Corporation of Canada and William Boyce Thompson, then a ruling figure in Wall Street, New York. Again supplies went in over the snow. Two shafts were put down, and they confirmed all that the diamond drills had promised. But Thompson, with many financial irons in the fire, began to be squeezed for cash about that time and felt obliged to withdraw. However, Scott Turner, the engineer assigned to the investigation by the Mining Corporation, saw the potential value of the claims and persuaded his principals to buy out Hammell and his associates for $600,000. Of this amount Creighton received $100,000. Thereupon, Turner started a painstaking examination of the holdings, assembling detailed data. By 1924 he was ready to present the proposition, and his employers approached Harry Payne Whitney, American financier.

Up to that time $1,500,000 had been spent and not a pound of ore had been treated. Whitney took a 2-year option on the property on September 30, 1925, agreeing to buy it if satisfied with what he learned during the interim. Having ascertained that there was ample ore, he sent tons of it to Denver, and thousands of tests were run on it at the Colorado School of Mines. Fortunately, selective flotation had come along and opened the way to treating the complex sulphides successfully.

Still cautious, the Whitney interests built a pilot mill at Flin Flon and operated it for months before becoming convinced that a commercial-size plant would function profitably. When the 2-year option had expired they asked for an additional two months and did not sign the purchase agreement until the final day of the allotted period. That done, they organized the Hudson Bay Mining & Smelting Company and raised $17,500,000 in working capital by selling its securities. In the meantime, William

Boyce Thompson, who apparently had always considered the proposition a good gamble, had bought the 35 percent interest of the Great Sulphide Company. The latter had tired of the long wait, especially as the skeptical public had long since dubbed the mine the "Flim Flam."

Once in control, Hudson Bay constructed a 45,000-hp. power plant on the Churchill River, ran in transmission lines, and persuaded the Manitoba Government to build a $3,500,000 extension from the Canadian National Railway that had been constructed through The Pas in 1905. Mining structures and milling plants were put up, and production was begun in October, 1930. More than fifteen years had elapsed since Creighton's discovery, during which time $22,000,000 had been expended.

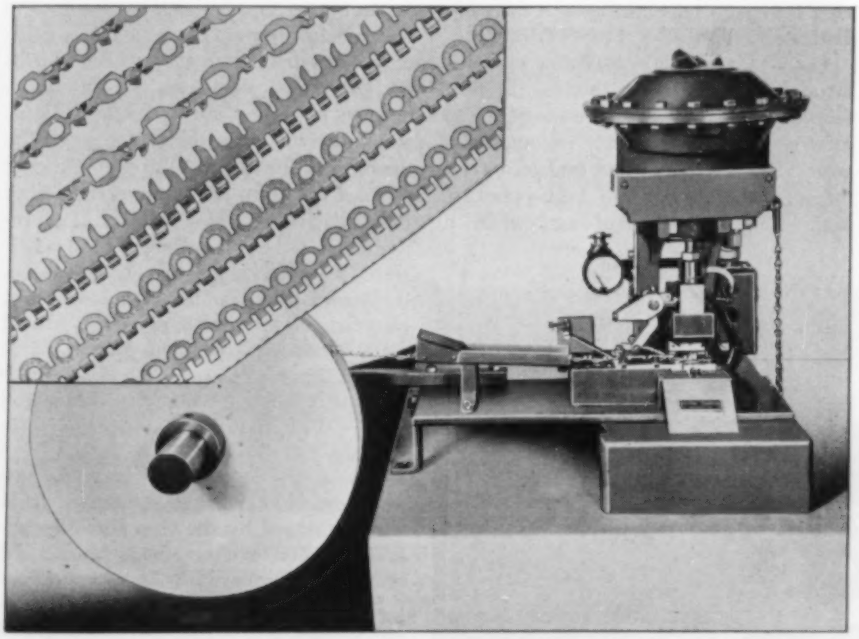
Despite the fact that the prices of base metals were low during the first years of operation, the property was soon on a paying basis. To date, it has disbursed some $60,000,000 in dividends. In 1947 it mined and treated an average of 5082 tons of ore daily and recovered 41,151 tons of copper, 52,897 tons of zinc, 120,678 ounces of gold, 1,580,268 ounces of silver, 172,896 pounds of cadmium, and 127,970 pounds of selenium. All told, they brought a return of $34,500,000.

Although Tom Creighton's part in all this has been well-nigh forgotten in the maze of events that have transpired since he tracked a moose into a treasure trove in 1915, the mine is still the Flin Flon and doubtless will be to the end of its days. Well-nigh on the spot where he made his discovery there now stands the most northerly smelter in the British Empire. As for Creighton, he fared better than the average prospector. He not only got $100,000 in cash years before the property became a producer, but during most of his final years was retained by Hudson Bay as head of its subsidiary exploration and transportation organization.

Air-Operated Soldering Machine

SOLDERING terminals to electric wires has been converted from a slow, messy job to a quick, neat mechanical function, according to an announcement by the Patton-MacGuyer Company. After nearly two years of testing under service conditions, that firm is building an air-operated machine that attaches and solders terminals automatically in one operation. It also supplies terminals of varying types and sizes. These, not the machine, provide the solder, of which they carry just the right quantity between the ears that grip the conductor to make what are claimed to be consistently uniform joints. They are in strip form and fed from a cardboard coil that is thrown away when empty.

Interchangeable dies are used, and a guide at the side of the die head enables the operator to place the wire in the terminal ears with ease. Heat is applied by standard electric heating units and is maintained constant even should the line voltage fall because of heavy loads elsewhere in a shop. An automatic dwell holds the assembly for the correct fraction of a second required to melt the solder. Air at a pressure of 50 psi. and more, applied to a diaphragm on top of the die head, operates the machine, which cuts each terminal from the strip and clinches and solders the parts at one time. Users of this quantity-production method report that they are attaching terminals at the rate of 10,000 to 12,000 a day.



TERMINALS AND MACHINE

Shown here are a few of the representative tandem terminals made by Patton-MacGuyer for use with its automatic attaching and soldering machine. They are fed from a reel through adjustable guides to interchangeable dies which, under pressure exerted by a diaphragm, cut them off one at a time and simultaneously clinch and solder them to the wire, which is inserted by hand.

New Mercury-Vapor Lamp

IT IS a well-known fact that the mercury-vapor lamp gives more light per watt than any other high-intensity lamp in use but that its cold-blue light has limited its field of application. The problem of adding color values without sacrificing efficiency has been a difficult one and has only recently been solved, it is authoritatively reported, by Luke T. Thorington, engineer of the Westinghouse Lamp Research Laboratories at Bloomfield, N.J.

Mr. Thorington has developed a fluorescent-type mercury lamp by powdering the inner glass surface with a special phosphor that converts the invisible ultraviolet into pure red light. Ordinary fluorescent-lamp phosphors are most effective at temperatures of 94°F., but the phosphor sought and found after testing more than a hundred batches fluoresces under temperatures of 750°. "The blend of mercury light and phosphor light," says Mr. Thorington, "is eight times richer in red than the light from regular mercury lamps of clear glass."

Experimental lamps of different shapes have been made by the new process, and of these one with a bulging midsection akin to an oil-lamp globe appears to be most efficient in light output and color correction. With the undesirable feature of the mercury-vapor lamp removed, the predictions are that it will be used for general lighting in some industrial plants and for flood lighting television and movie studios, sports arenas, and similar places.

Mist Spraying of Trees

High-Velocity Streams of Air Apply Insecticides Better and Quicker Than Older Methods

UNIT UNDERGOING TEST

Truck-mounted sprayer being tried out in winter near the factory at York, Pa., where it is made.

BITTER and unceasing warfare must be waged by farmers, orchardists, arborists, and others against insect pests that prey on plant life or are a menace to public health. Lethal solutions of one kind or another are the most effective means of combating these harmful creatures and have been commonly applied by hydraulic spraying, which involves the use of conventional pumps, tanks, hoses, and nozzles. Although it serves the purpose, the method is wasteful as compared with mist spraying, a recent development by which a liquid insecticide is injected in fine droplets into a stream of high-velocity air induced by a motor-driven fan or blower.

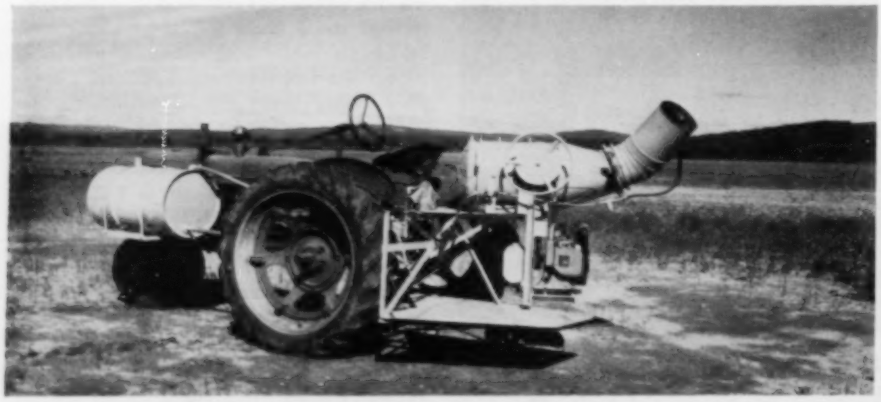
Mist spraying, in itself, is not new, as all basic patents covering the process were granted by 1924. However, its application was limited until of late years because the insecticides formerly available were more suitable for hydraulic spraying. Far more powerful preparations have appeared in the meantime. DDT, one of the best known, is an extremely toxic compound that has been used with great success in controlling the gypsy moth, mosquito, housefly, etc. It lends itself well to mist spraying and has been largely responsible for bringing the method into prominence.

Machines designed for mist spraying are of two types which differ mainly in that one has an open and the other an enclosed fan. The first, or free-air unit, depends for its carrying power—the distance the air stream will convey its load of insecticide—on the blast of air delivered by the fan. The enclosed type, which is essentially a rotary compressor, draws free air into the fan housing through a large opening and ejects it from a smaller aperture, the pressure at which the air emerges from the nozzle, plus velocity, determining the carrying distance.

Because spraying jobs differ in magnitude, each machine—that is, the fan, diffuser, and nozzle—must be designed to meet service requirements. Woodlands, large areas of marshy ground, etc., call for a unit delivering a high-pressure, high-velocity stream of air, while a sprayer producing a large volume of air at low velocity and pressure is adequate for individual trees and hedgerows, or the local control of flies and mosquitos.

Either oil- or water-mixed insecticides may be used. The liquid is drawn from a supply tank by gravity, siphoning, pumping, or by pressure induced by a supercharger or an auxiliary fan and is reduced to droplets by spray jets, spinning disks or fans, or by perforated tubing. The size of the drops is less important with water than with oil solutions, which are further atomized through the medium of the nozzle. Droplets ranging in size from 36 to 100 microns have been found to give the best results. If oil insecticides were not properly diffused, it would be necessary to use air at a velocity exceeding 150 miles an hour instead of 90 to 100 miles to spray them. Field tests over an extended period have proved that air blasts of 90 miles an hour will not defoliate even at close range and that a 100-mile blast is sufficient for treating tall shade trees.

Among the several mist sprayers now on the market is the one illustrated. It was developed by the Greenfield Sprayer Company, of Greenfield, Mass., and named the Orchardair. In recent weeks it has been acquired by the A.B. Farquhar Company of York, Pa., and renamed the Iron Age. The machine has a solid, cast-aluminum, axial-flow fan mounted on heavy-duty ball bearings and is driven by two V-belts from a 2-cylinder, air-cooled, 10-hp. gasoline engine. Operating at 87 percent efficiency when re-



TRACTOR-MOUNTED SPRAYER

One of the many ways in which units are made mobile. The liquid to be sprayed is stored in the tank on the left.

volving at 3020 rpm., the fan delivers air at the rate of 6500 cfm., which is discharged from the 12-inch nozzle at a velocity of 90 miles an hour.

A pump forces the insecticide from a 40-gallon tank to the spray head, through which it is introduced into the air stream. Interchangeable heads are provided, permitting a coverage of from 1 to 20 and more gallons an acre. The solution in the container is continually agitated in the course of the operation by liquid flowing back from the pump into the tank through large holes near the bottom.

Directional control of the air stream is obtained in two ways: by rotating the curved nozzle through a 330° arc and by turning the entire machine in any desired direction. The nozzle is moved by means of a steering wheel and cables, and the sprayer by a turntable on which the whole outfit rests. Locking devices on the base serve to hold the unit firmly in position. The Iron Age is normally equipped with skids that permit towing, but it may be mounted on a pick-up truck, a jeep, a boat, or other form of rapid transportation. A light trailer makes a handy carrier because it can be disconnected to free the tractor for other service at the working site.

Mist spraying is said to have many advantages over the hydraulic method. The machines are compact and can be readily shifted from place to place. Because the solution is broken up into very fine particles, a little of it goes a great ways. In the case of an oil mixture, for example, from 1 to 3 gallons per acre generally meets all requirements as to coverage and effectiveness. Furthermore, less work is involved, because a given amount of insecticide or fungicide that would have to be mixed with 100 gallons of water when applied by hydraulic spraying would call for the use of only 10 gallons of water by mist spraying. Another factor in favor of the latter is that it permits treating trees overhanging sidewalks, for if the work is properly done there is no danger of runoff or dripping from foliage on pedestrians and parked cars.

Air Power Essential in Building Curundu Culvert

AIR power has served extensively in the construction of the Rio Curundu Culvert, a $1^1/_3$-mile-long underground storm-water drain of concrete that was recently completed at Balboa, Canal Zone, by the Frazier-Davis Construction Company and the MacDonald Construction Company, both of St. Louis, Mo. The $2,500,000 job was carried out for the Corps of Engineers, U. S. Army, under the direction of Col. McD. D. Weinert, district engineer for the Panama District. E. H. Kersting was general superintendent for the contractors.

Compressed air was used to operate pile hammers for driving both sheet piling in a cofferdam and concrete bearing piles, an extractor for pulling sheet piles in dismantling the cofferdam, concrete vibrators and sump pumps needed all along the working area, and a Tugger hoist for moving wall and roof concreting forms. The hoist was shifted along the invert and anchored in form bolt holes whenever either set of forms had to be advanced. Air was always ready, too, for cleaning forms before placing concrete.

PORTABLE AIR RECEIVER

Trailer-mounted 4x30-foot tank fitted with a manifold having five connections for hose lines from as many portable compressors.

At the peak of operations, the job required the output of six compressors having a combined capacity of 2630 cfm. Portable units were selected for the service because they could progressively move ahead to keep abreast of the work. To provide adequate air storage, a 4x30-foot receiver was mounted on a trailer for mobility. It was equipped with a manifold or "sow" with connections for hoses from the various compressors, as shown in the accompanying picture.

TESTING FOOTBALLS FOR LEAKS

To test newly made footballs for leaks, Collette Manufacturing Company of Amsterdam, N. Y., formerly kept them inflated for a 10-day period of observation. This time-consuming procedure required carrying as many as 200,000 balls as "in-process" stock and also failed to reveal very slow leaks. Now, using a General Electric detector as shown here, they are tested quickly as they come off the production line. During inflation, a small quantity of Freon gas is added to the compressed air. Then a sample of the atmosphere surrounding the ball is drawn into the detector, and if there is a trace of Freon present the instrument indicator shows it. The detector is sensitive enough to locate a leak as small as one one-hundredth of an ounce a year. It is used for leak-testing various pressure systems ranging from refrigerator coils to airtight parts for atom smashers.

Boiler Paid Dividends

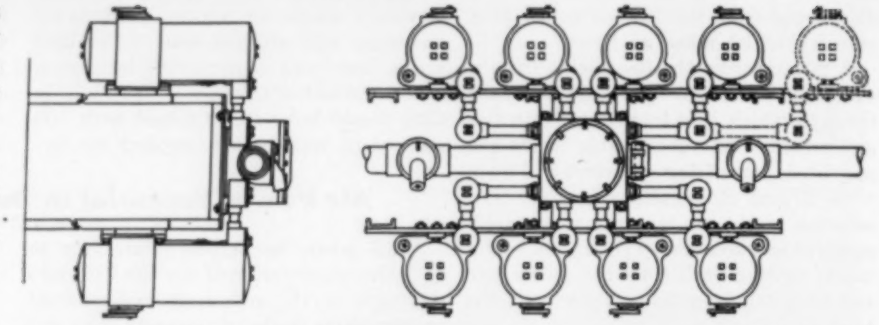
WE HAVE often read about equipment that "pays for itself." That this is actually true on occasions is proved by an instance reported in a letter that recently appeared in *The Engineer*, a British technical publication. It relates to the late Sir George Willis, an English engineer who was assigned by his government to serve in the Bombay, India, mint during World War I. In anticipation of the need for additional coinage during the war, it was decided to increase the mint's power-generating facilities. An inspection of the massive steam engines that had served for nearly 100 years revealed that they could be operated at double the prevailing pressure, and it was decided to retain them but to provide new boilers. After the changes had been made, the old boilers were examined and found to be of solid copper more than an inch thick. The metal was melted down, alloyed properly, and converted into coins whose value was greater than the initial cost of the original boiler plant plus that of the new equipment.

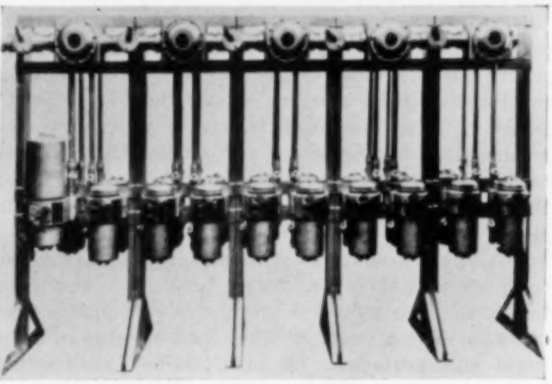
Industrial Notes

Window shades that will char but not support combustion are being made by Du Pont in a wide range of fast colors. The product, called Tontine, can be cleaned with soap and water.

A process has been developed which is said to make concrete blocks and face them with marble at one and the same time. The marble is an integral part of the building material, which provides a finished interior or exterior wall. Manufacturers can obtain licenses to use the Knighton Process.

Switzerland watchmakers have developed a timepiece with a precision slide rule built around the dial. When the rim in which the crystal is set is turned, the slide index, made of unbreakable glass, rotates automatically. This calculating Juvenia wristwatch is available in two models: in polished stainless steel and in 18-carat gold. It is called Arithmo and is sold by George Jensen, Fifth Avenue, New York.





Explosionproof motor-control equipment to suit individual needs is being designed and assembled by the Electro Mechanical Devices Company for use in refineries, utilities, and other industries where safe conditions are of paramount importance. This new Emdco service is made possible through coöperation with Crouse-Hinds Company, manufacturer of explosionproof conduit enclosures, and offers control centers and power panels of simplified unit construction that meet the requirements of the National Electrical Code and of the most rigid local codes covering all installations in Class 1 and Class 2 hazardous locations. In addition, the company is prepared to give engineering service. The assembly pictured consists of five motor-control groups which provide complete control for twenty motors, or four each. This installation includes junction boxes, sealing fittings, and combination starters, all in watertight and dust-, weather-, and explosionproof housings. The diagram shows the plan and end view of an 8-motor unit having the same components. Both are free-standing, but may be built for wall mounting. The equipment is available with or without instrumentation.

For development work and small-lot production of valuable chemical and pharmaceutical materials, Bowen Engineering, Inc., has redesigned its Laboratory Spray Dryer. The new model features a gas furnace that heats the inlet air to 750°F., maximum, with an increase in evaporation rate of 30 percent; a feed pipe with a bigger diameter to handle viscous solutions or slurries that previously required the use of large units; stainless-steel ducts between the heater and the drying chamber; and dial thermometers that furnish inlet and outlet temperatures of the gas. The dryer contains a small turbine that is operated by compressed air at a pressure of 100 psi. to drive an atomizing wheel in the drying chamber at speeds up to 50,000 rpm. The liquid or slurry is thrown outward in a fine mist, from which the moisture is extracted instantaneously, leaving the solids in a powdery form. This is done by hot, turbulent air currents introduced through a vaned inlet surrounding the drying chamber. At the bottom of the latter is a patented sweeper which cools both the floor and the powder with a stream of air at room temperature. The air and the entrained solids enter a cyclone collector where they are separated, the powder being deposited in a Pyrex jar and the air exhausted to the atmosphere. It is claimed that it takes but a few seconds to transform liquids into dry solids and that heat-sensitive materials can be treated with safety.

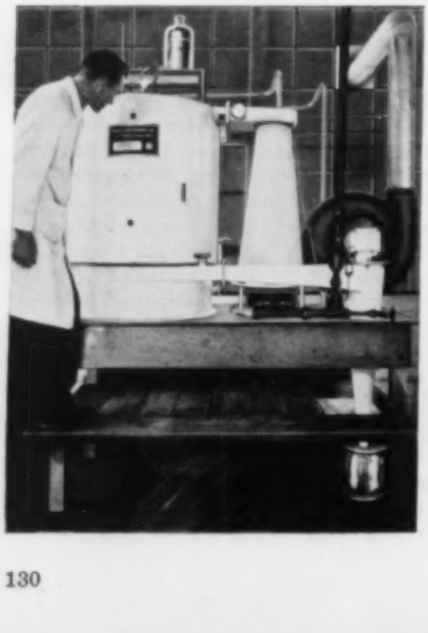


TABLE-MODEL DRYER

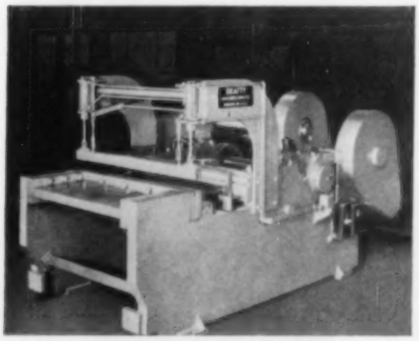
Feed rate may range from 50 cubic centimeters per minute for extremely heat-sensitive products requiring low-temperature inlet air and supplemental cooling air to more than 500 cubic centimeters under favorable conditions. Solution or slurry may be fed by gravity from a graduated funnel, by a metering pump, or by a blow chest using low-pressure air. The drying chamber with inlet-duct assembly is hinged so it can be tipped back for cleaning.

Something new in ceramic surface plates is being produced by Norton Company for use in toolrooms and inspection departments where precision set-ups and checking measurements require the highest degree of accuracy. It is made of one of the hardest substances known, is nonmagnetic, and may be cleaned with soap and water. According to the manufacturer, laboratory tests have shown the life of the plate to be at least 40 times longer than that of the best competing type; that it will not sweat or corrode under atmospheric conditions; and that it will not warp, give expansion troubles, or deflect under load. Its surface is guaranteed to be flat within 0.0001 inch.

Flame-Seal is a new fire-retardant paint for raw wood surfaces. It was produced by the Stallton Chemical Corporation after twelve years of research and is an oyster-white flat finish that fire transforms into a hard protective crust at least eight times as thick as the original coating. It is claimed that lumber so treated will not support combustion even after exposure to the heat of a blowtorch (2000°F.) for 30 minutes and will not generate smoke and toxic gases. It is also said to be termiteproof, and washing with standard soaps or powders will not impair its effectiveness. The paint can be applied from its own container by brush or spray gun and is recommended for home and industrial use.

Checker flues in open-hearth furnaces are hard to clean by hand scrapers but not by a type of boiler-tube cleaner such as has been tried recently by the Worth Steel Company. The tool consists of an air motor connected to a drill head through an extension piece; and a 1-inch pipe coupled to an air line is screwed into the cleaner for ease of handling in the vertical position. Where hand labor did a none-too-satisfactory job in 170 hours, the checkerwork is now cleaned well with the pneumatic device in 60 man-hours.

What is believed to be the first machine for punching a long line of holes horizontally through flanges on long, wide plates has been built by the Beatty Machine & Manufacturing Company. Punch tools are mounted on varying centers across the face of the ram, which extends from end to end of the 72-inch-long work table. The machine has a 6-inch stroke and is provided with a pneumatic clamping device to hold the material down for gauging purposes while punching is in progress. Stripping is done by two pneumatic cylinders that move with the ram. The auxiliary equipment can be varied to meet customer's needs. Punches are operated by motor through V-belt, and clutches are of the jaw type. They are available in capacities ranging from 50 to 300 tons. The one pictured is a 200-ton unit.



Du Pont has produced vitreous enamels for two aluminum alloys—No. 61-S wrought aluminum and No. 43 casting alloy—and is continuing its research in this field of protective and decorative coatings. They may be applied to strip or sheet stock as well as castings by spraying or dipping, and are fired in furnaces like those used in enameling steel, but at considerably lower temperatures. The new finishes contain lead and are not suitable for coating kitchenware and equipment that comes in contact

"VIC" TELLS HOW

OUR SIMPLE 2-BOLT COUPLINGS SAVE YOU LABOR COSTS!

Vic Victaulic
Sizes—¾" through 60"

YOU DON'T NEED specially trained or skilled labor to "button-up" 2-bolt Victaulic couplings. Just a few turns of a T-wrench . . . the only tool needed . . . and you have a *positive* yet *flexible* lock that is *slip-proof* without excessive bolt tension.

NO GUESSWORK . . . no need to mark pipe. Victaulic couplings center *automatically!* And when it comes to salvage, replacement, or repair . . . you save on labor costs again. Victaulic gives you *a union at every joint*, and to remove any individual pipe length, valve or fitting, you just dismantle two joints anywhere in the Victaulic line. No need to disturb adjoining sections nor injure pipe ends or couplings.

SAVE MONEY at every step! Victaulic *Full-Flow* Elbows, Tees and other Fittings reduce frictional losses . . . increase your pipeline output *at lower pumping costs.*

ANOTHER BIG MONEY SAVER is the "Vic-Groover" . . . the new tool that grooves pipe ends exactly right . . . *automatically* . . . and with *twice the speed* and *half the effort* of ordinary pipe threaders.

WRITE TODAY for these two catalogs that can save you time and money: Victaulic Catalog and Engineering Manual No. 44, "Vic Groover" Catalog No. VG-47.

FOR FULL ECONOMY...MAKE YOUR PIPING SYSTEM ALL VICTAULIC!

SELF-ALIGNING PIPE COUPLINGS
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ECONOMIZE
as you
MODERNIZE

... Motor Control Centers

CONTROLLING motors on a process? Economize with standardized, pre-engineered and factory assembled G-E motor control centers. Vertical sections are only 12 inches deep. Standard starter units (NEMA Size 1, 2, 3, and 4 for 1 to 100 hp motors, 440 volts and below) are completely metal enclosed, have short-circuit and overload protection.

Save on wiring costs. Connections to incoming power from vertical bus bars are made in one quick shove by means of "clothespin contact", a special device on the back of each starter unit. Four screws hold unit in place. Wiring troughs are five inches wide, easily reached when cover plates are removed. Terminals are at top or bottom as you prefer. Everything front connected for flexibility of arrangement. Write for more details on these low-cost G-E motor control centers—Bulletin GEA-4979—at the nearest G-E office. *Apparatus Department, General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

730-1

with food. Recommended applications are manifold and include outdoor furniture, advertising display letters, storefront panels, and architectural tile. Flat material can be cut and fitted on the job.

Speed of operations on a sewer-pipe job was attributed by the contractor to a pneumatic guniting machine that he used to prejoin three lengths of small-diameter concrete pipe before lowering them into the trench. The joints of the assembled sections, each of which has one flanged end, were filled with cement mortar by the spray gun, permitting 600 feet of pipe to be laid in an 8-hour shift.

A new model Transometer that will generate an air-pressure signal from 2 to 15 pounds has been designed by the Askania Regulator Company. The unit can be used directly with present types of air-operated controllers without the need of a transformer to convert the usual Transometer low-pressure signals to the desired 2-15 psi. values. With its extended pressure range it permits of broader application in the field of liquid flow.

Draftsmen, engineers, and architects can "take the load off their feet," says Cramer Posture Chair Company, Inc., which has designed a chair that gives them "absolute seated comfort." Everything is adjustable without the use of tools—height of seat and back, depth of seat, a forward-tilting mechanism that causes the seat and back to follow the motions of a draftsman as he leans forward to work at the upper part of his drawing board, and a footrest. Some of the models, like the one shown, are provided with casters by which the man in the seat can roll himself easily from side to side of his board. There is no danger of the chair turning over, it is claimed, because of the span of the legs.

Industrial Literature

Information concerning a new-model automatic air filter is contained in a bulletin recently issued by the Dollinger Corporation. The filters are of the vertical, traveling-curtain, self-cleaning type, and are designed for use in industrial plants where large volumes of air must be cleaned. Copies may be obtained from the company at 11 Center Park, Rochester 3, N. Y.

Separation of entrained liquids from vapors by means of wire-mesh filtering elements is described in Bulletin 11 offered by Otto H. York, Inc., 364 Glenwood Avenue, East Orange, N. J. It discusses separation as conducted in mist extraction, gas filtering, tower packing, cleaning, baffling, and similar operations, and tells how knitted wire-mesh filters can be used to advantage in this work. Copies will be sent upon request.

Bulletin 722 just issued by The Louis Allis Company describes its new line of single-phase motors built in capacitor start-induction run types in ratings of 1 and 1.5 hp. and in capacitor start-capacitor run types in ratings from 2 to 10 hp. They are available in open, drip-proof, splash-proof, totally enclosed, fan-cooled or explosion-proof construction. The bulletin may be had by writing to the company at Milwaukee 7, Wis.

Obtainable from Hose Accessories Company, Seventeenth and Lehigh Streets, Philadelphia 32, Pa., is a catalogue describing its complete line of hose fittings. Throttle valves for compressed-air service, universal-type detachable air-hose couplings, air-hammer hose couplings, long-shank couplings for low-pressure steam and spray hose, special high-pressure couplings, and hose clamps are some of the items described and illustrated.

Ingersoll-Rand Company, 11 Broadway, New York 4, N. Y., or any of its branches, will send upon request a 32-page booklet explaining the advantages to be gained by substituting Carset Jackbits for regular steel rock-drill bits. It tells how the new type, which has tungsten-carbide inserts, effects considerable savings in cost because it drills a much greater footage in a given time than the older bit. Case histories of results obtained are listed, and methods of converting from regular to Carset Jackbits are given.

Air-operated devices by which standard machine tools are converted into fast, automatic production units are explained in a booklet obtainable from The Bellows Company, 222 West Market Street, Akron, O. Designed primarily for feeding work into drill presses, milling machines, planers, saws and similar equipment, they can also be used for many other purposes such as operating wrapping machines, paint sprayers, and slides in grain chutes; loading and unloading conveyors; opening and closing furnace doors or valves; and clamping castings for grinding or chipping.

Condensers for ammonia or Freon are dealt with in Bulletin RC-1 published by Henry Vogt Machine Company. In addition to describing their construction and operation, it contains tables giving the properties of the refrigerants at different pressures and temperatures, as well as the safe internal and external working pressures for steel tubes. The condensers are available in a wide range of sizes and capacities in both single- and multipass types for either vertical or horizontal installation. Copies of the bulletin may be obtained from the company at Louisville 10, Ky.

THIS NAYLOR COMBINATION IS OUTSTANDING IN MINING SERVICE

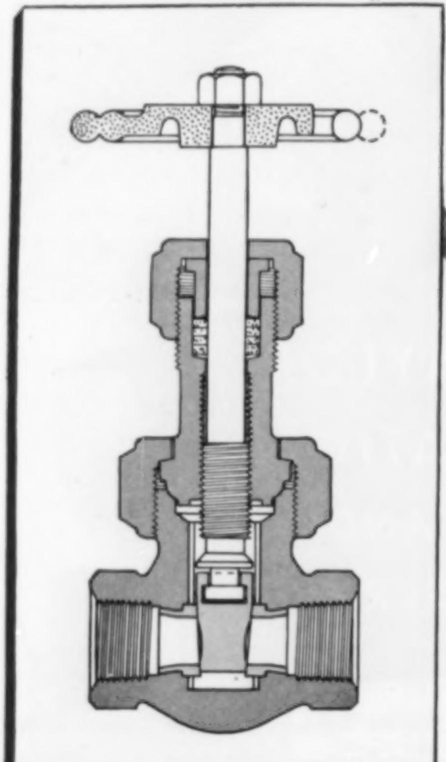
This picture shows Naylor light-weight pipe joined with Naylor Wedge-Lock Couplings—a sight that is becoming more and more familiar in the mining fields because of the unusual advantages of this combination. The pipe provides light weight, greater safety and economy without sacrifice of strength. The couplings simplify and speed up connection. Together, these Naylor products give you lines that out-perform ordinary light-weight pipe in high or low-pressure service. Sizes from 4" to 30" in diameter.

Naylor Pipe

NAYLOR PIPE COMPANY
1245 East 92nd Street, Chicago 19, Illinois
New York Office: 350 Madison Avenue, New York 17, N. Y.

"Where can I get compact, high quality, high pressure Gate Valves for general service?"

"Order VOGT Series 9850"*



Operating men everywhere rate these valves as tops for general gate valve service including meter and gauge lines, drip and drain lines, etc.

Series 9850 valves have drop forged carbon steel bodies and bonnets, rolled in 11½-13% chrome stainless steel seat rings which can be easily renewed, and a solid stainless steel wedge. A ground joint insures tightness between body and bonnet. The stuffing box can be repacked under pressure when the valve is open.

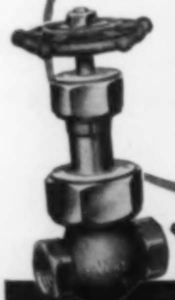
Also available is Series 9750, completely fabricated from 18-8 stainless steel for services where internal or external corrosion is severe.

Series 9850-F8 valves have 18-8 stainless steel trimmings and carbon steel bodies and bonnets.

***Series 9850**

CARBON STEEL } 800 Pounds @ 750° F.
1500 Pounds Cold Non-Shock

For 150-800 pounds general service Union Bonnet • Ground Joint • Inside Screw Stem • Renewable Seat Rings • Solid Wedge—Slotted Type • 11½-13% Chrome Stainless Steel Trimmings Sizes ¼" to 2" inclusive.



HENRY VOGT MACHINE CO.
Louisville 10, Ky.

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Vogt DROP FORGED STEEL VALVES

Research keeps

BFG

FIRST IN RUBBER

Photo courtesy Independent Pneumatic Tool Co.

New hose for "hard-to-get-at" jobs weighs 50% less, handles easier

B. F. Goodrich Highflex hose cuts weight, multiplies flexibility

NEW HIGHFLEX air hose, developed by B. F. Goodrich for small air tools, is twice as light as ordinary air hose, many times more flexible and easy to use in tight corners. And you actually get *higher* burst strength in Highflex than in heavy, old-type hose, same size. You get these important advantages with Highflex—

50% weight saving—Here are the figures: A 100-ft. length of Highflex weighs 8.8 lbs. in ¼" size. Ordinary hose in the same size weighs 20 lbs. All sizes of Highflex give you substantially similar savings.

Flexible as a lamp cord—Highflex gives you a lightweight line, easier to use in close quarters, to keep kinkless and unsnagged. Reduce fatigue of your workers, make their operations faster and more efficient.

Strength to spare—Working pressure of 250 lbs. gives Highflex a high margin of safety for any air tool job. Single ply, double braid reinforcement gives low expansion under pressure, minimum contraction of length.

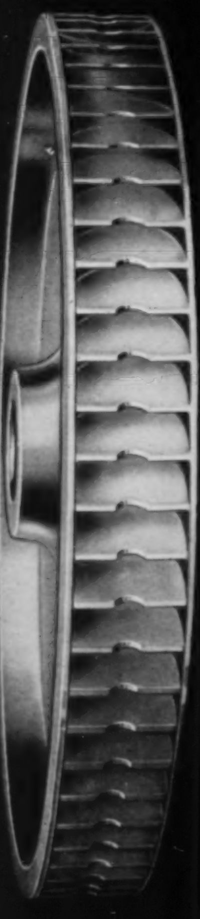
Oilproof inside and out—Highflex is completely oilproof. Oil to lubricate the tool won't cause the hose to swell and flake off, won't cut air volume or jam the tool. Dragging it through oil won't harm the cover.

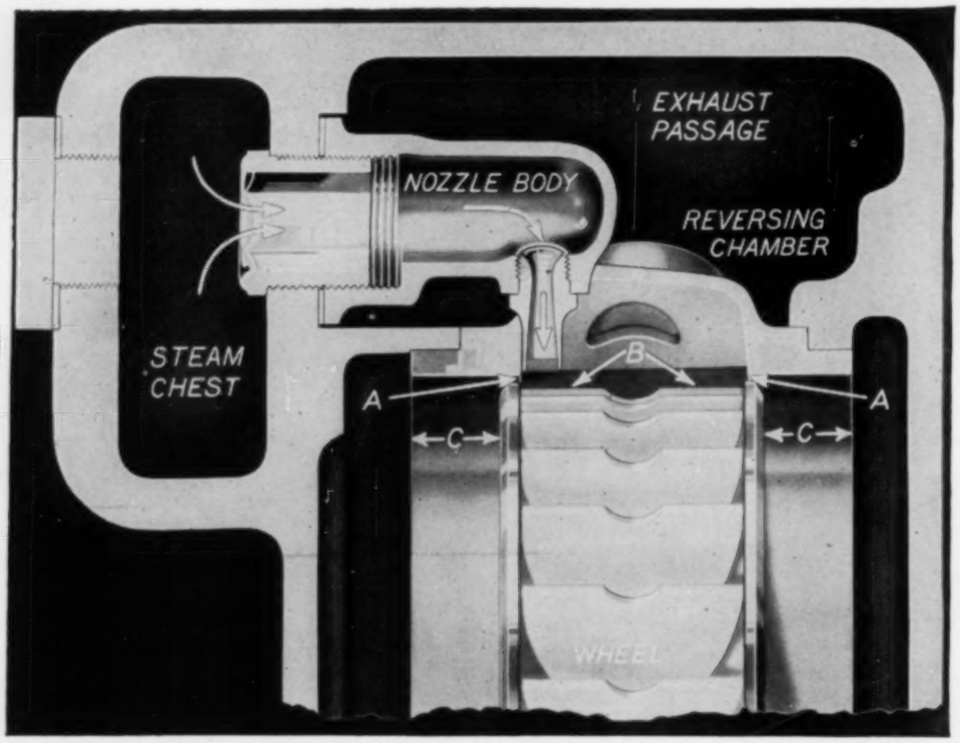
Highflex also has—Bright red color of high visibility—easy to keep clean. Cover specially compounded to resist sun checking, tearing, snagging, and abrasion. Small bulk—takes up less storage space when coiled. Your BFG distributor will be glad to demonstrate Highflex and quote prices. *The B. F. Goodrich Company, Industrial Products Division, Akron, Ohio.*

B.F. Goodrich

RUBBER FOR INDUSTRY

TERRY





AMPLE CLEARANCES FOR DEPENDABILITY

Large blade and rim clearances and extra large side clearance — one inch — help make Terry One-piece Wheel Turbines highly dependable in operation.

The blades cannot foul because of the protection afforded by the rims, which are not damaged, should rubbing occur.

Note the rim clearance, AA in diagram. Also the large blade clearance, B. Side clearance, CC, is so large that end-play from external thrust cannot damage wheel.

Terry Bulletin S-116 will give you full information on the Terry Wheel Turbine. A request on your business letterhead will bring you a copy.

T-1171

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

When a company specifies the same pump material 3 times, you have proof that...

NI-RESIST defeats salt water corrosion

The Narragansett Electric Company now has three of these giant pumps made by Ingersoll-Rand to handle corrosive sea water.

This large pump is a repeat order from the Narragansett Electric Company, Providence, R. I. It is for condenser circulating service, and confirms the value of two similar units installed at the Manchester Street Station in 1947.

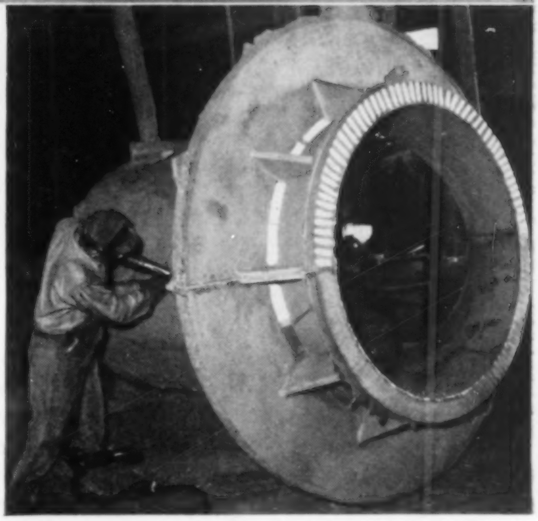
Though the station is located on a river, tide brings salt water up to the plant. To assure maximum resistance to the attack of this contaminated, brackish water, all three pumps had Ni-Resist*, a nickel alloy cast iron, specified for casings, outer columns and discharge heads.

No other product of the cast iron industry matches Ni-Resist for economical performance under corrosive conditions. This austenitic nickel-chromium cast iron with its dense, close-grained structure also curbs erosion, and remains free from leaks or pressure losses despite high hydraulic pressure.

Readily machinable, and combining strength along with extra toughness, Ni-Resist castings prove an economical solution to many complex corrosion problems throughout industry.

Write for our recommendations regarding the best nickel-alloyed iron or steel for your application.

*Reg. U. S. Pat. Off.



DISCHARGE HEAD under construction. To ensure long dependable service under corrosive conditions, this pump utilizes Ni-Resist for casing, outer column and discharge head; 18-9 chromium-nickel stainless steel for main shaft; 28.5-11 chromium-nickel stainless steel for impeller. Driven by a 450-hp. Westinghouse vertical motor at 289 rpm. The unit can pump 60,000 gpm. against a 22.6-ft. head. Total weight, not including driver, is 28,000 lbs. The pump is made by Ingersoll-Rand, Phillipsburg, N. J.

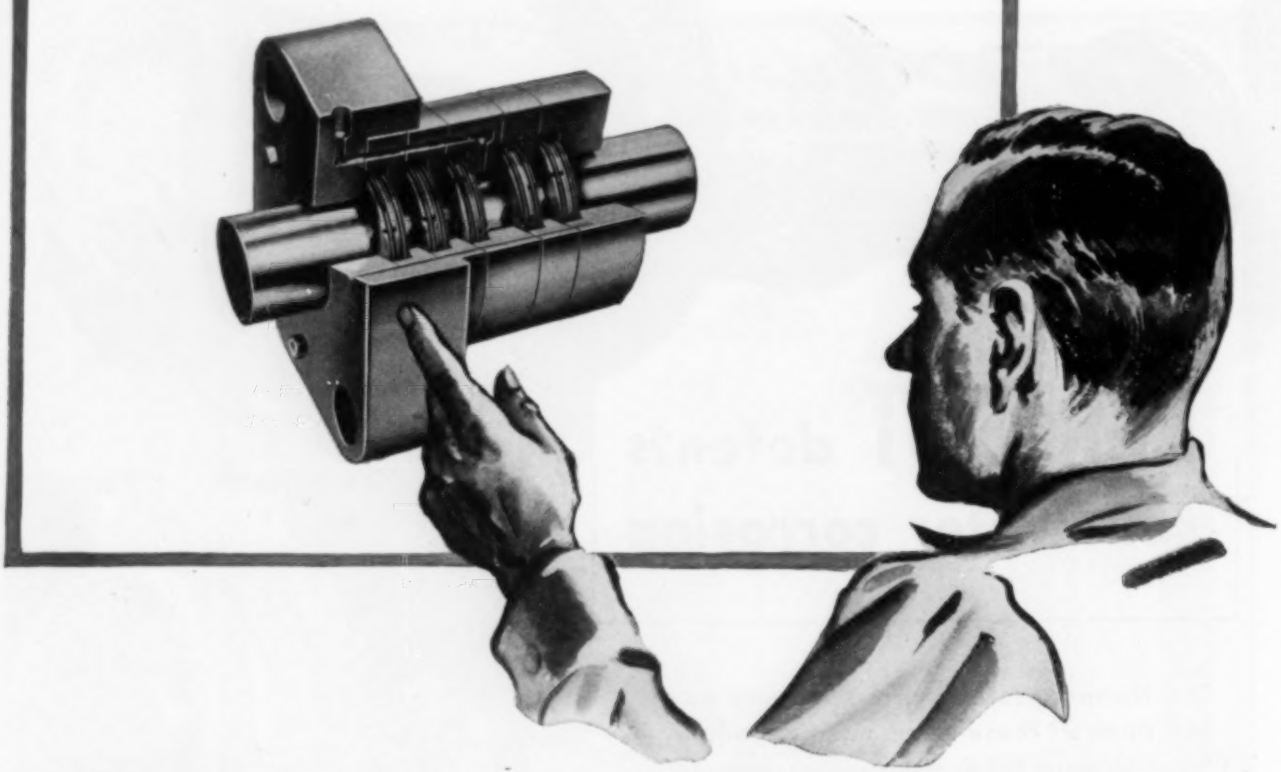
EMBLEM OF INCO SERVICE

Over the years, International Nickel has accumulated a fund of useful information on the properties, treatment, fabrication and performance of engineering alloy steels, stainless steels, cast irons, brasses, bronzes, nickel silver, cupro-nickel and other alloys containing nickel. This information is yours for the asking. Write for "List A" of available publications.

THE INTERNATIONAL NICKEL COMPANY, INC.

67 WALL STREET
NEW YORK 5, N. Y.

Why COOK ROD PACKINGS *are first by choice!*



WHETHER you operate or build compressors, the rod packings you use should make the machines work better, last longer and cost less to operate and maintain. If you select your packings on this basis, you'll choose Cook Metallic Packings every time, because they are engineered to do just that. Here's why:

1. Cook Rod Packings incorporate all the advantages gained from 60 years of specialization in the design, manufacture and application of full floating metallic packings.
2. The exclusive wear-resisting materials used in Cook Packings are produced under conditions which assure close scientific control. Only Cook in the industrial field operates its own ferrous and non-ferrous foundries under a recognized metallurgist.
3. Cook Rod Packings are made with modern manufacturing facilities capable of achieving fine micro-finishes and of meeting exacting tolerances.
4. Cook Rod Packings are serviced by an extensive field organization to insure users of full economies of these modern rod seals.

Because of these advantages, Cook Packings are used as original equipment by the major compressor manufacturers, and are specified by leading operators when ordering new equipment. Be sure that you, too, get the genuine. When you order, specify COOK Metallic Packings.

C. LEE COOK MANUFACTURING CO.
INCORPORATED
LOUISVILLE, KY.
BALTIMORE • BOSTON • CHICAGO • CLEVELAND
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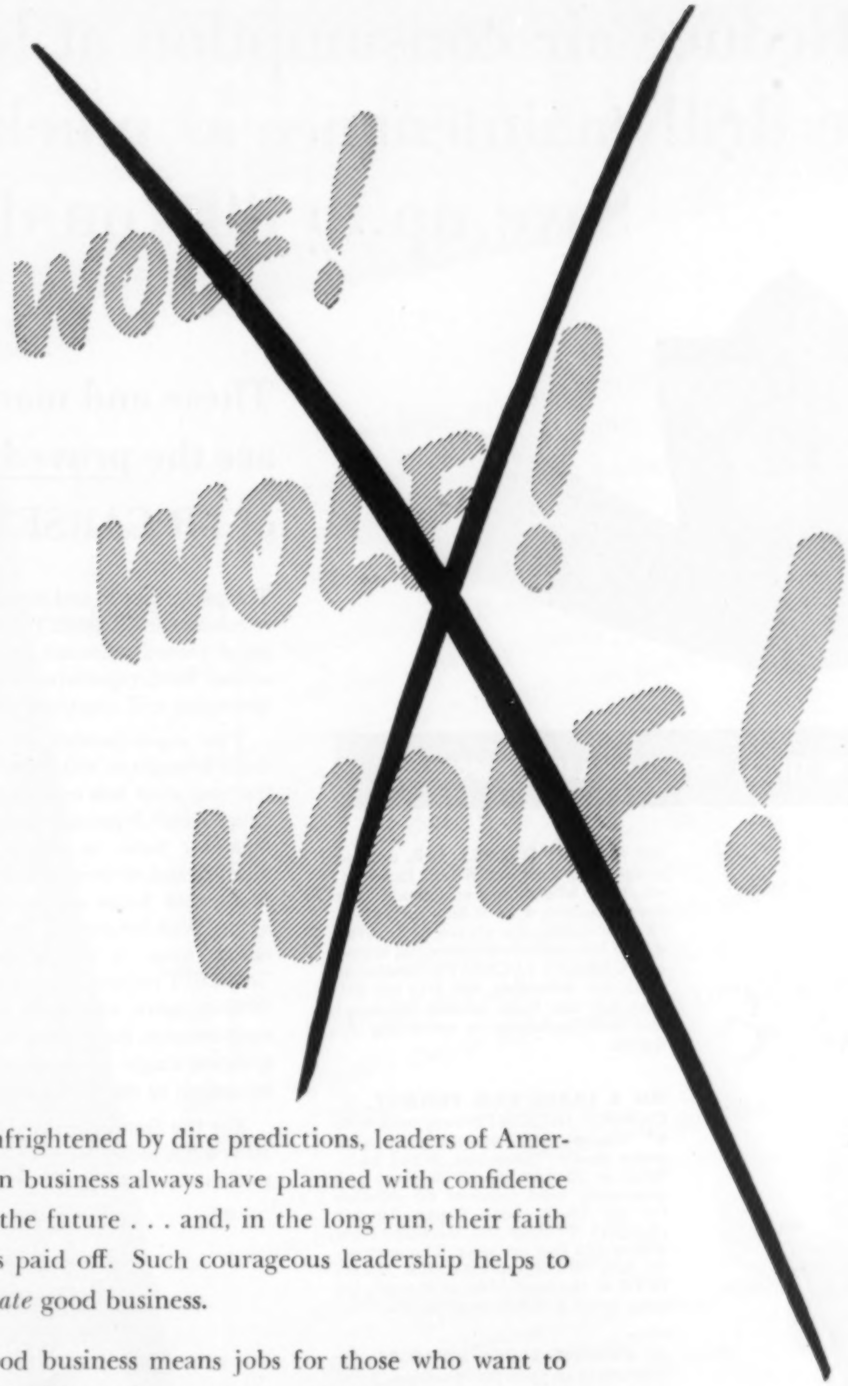
Sealing Pressures — Since 1888

BETTER PACKING FOR MORE EFFICIENT RESULTS—THROUGH METALLURGY


WOLF!
WOLF!
WOLF!

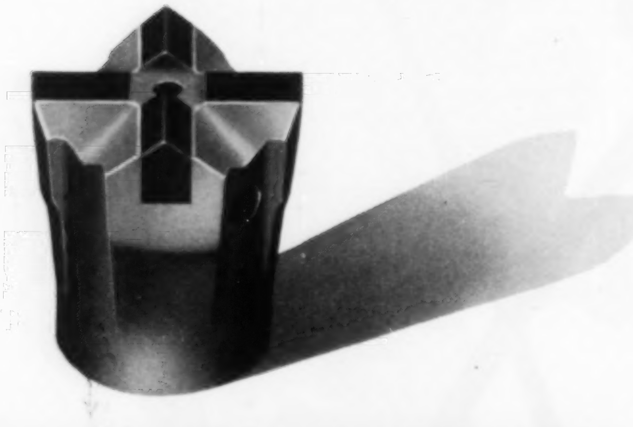
Unfrightened by dire predictions, leaders of American business always have planned with confidence in the future . . . and, in the long run, their faith has paid off. Such courageous leadership helps to *create* good business.

Good business means jobs for those who want to work. It's the best defense against the termites who are working to undermine the individual liberties Americans enjoy. 6593

SKF INDUSTRIES, INC. PHILADELPHIA
BALL and ROLLER BEARINGS

Carset Jackbits

Reduce air consumption at least 40%
Reduce drill maintenance as much as 30%
Save up to 30% on dynamite



These and many more are the proved advantages of I-R CARSET JACKBITS

The performance and economy of Ingersoll-Rand's revolutionary CARSET JACKBIT are now a matter of record – proved by more than two years of actual field experience on all types of mining, quarrying and construction jobs.

This super-Jackbit set with Carboloy inserts, drills from 50 to 400 times as many feet of hole as the best steel bits available – with no appreciable gauge wear! It permits drilling of smaller, uniform-diameter holes to any practical depth, without binding and without bit changes. The elimination of tapered holes saves up to 30% on dynamite alone. And because it drills so much faster and easier, even in the hardest rock, the CARSET JACKBIT reduces air consumption per foot of hole 40% or more, and saves as much as 30% on drill maintenance. No wonder rock-drill men call it "The greatest single advance in rock drilling since the invention of the Jackhamer."

For the complete story on the CARSET JACKBIT, write today for your copy of our new 36-page, pocket-size catalog, Form 4091.

HERE ARE A FEW TYPICAL REPORTS ON CARSET PERFORMANCE

ON A LARGE QUARRY JOB, drilling in hard trap rock with 45-lb. Jackhamers, steel bits dulled so quickly that they required 4 to 6 bits for a 2-ft. change – also the strain of forcing dulled bits caused excessive rod breakage. CARSET JACKBITS, now being used, are averaging 300 feet per bit. Rod life has been greatly increased and drill maintenance materially reduced.

ON A LARGE DAM PROJECT, 2" CARSET JACKBITS were used with 4" Wagon drills operating in hard dense basalt. These bits drilled 24-ft. holes in 22 minutes, while steel bits previously used required 66 minutes for an 18-ft. hole (with 10 bit changes). Footage was increased from 120 to 261 feet per shift. The contractor says "If I'd had CARSET JACKBITS at the beginning of the job, I'd have saved $75,000 to $100,000."

IN DRILLING LARGE BOULDERS, for blasting in an open pit operation, Jackhamer operators increased drilling speed from 4 inches per minute with steel bits to 10 inches per minute with CARSET JACKBITS. This combination of higher drilling speed and the saving of time previously lost changing bits, permitted them to complete 60% more plug holes per day.

A MINING COMPANY, drove 223 feet of 8 x 8 cross-cut in typical siliceous rock with 3" drifters and 1½" CARSET JACKBITS. Eighteen bits were used, averaging over 300 feet per bit. By drilling small uniform diameter holes with CARSET JACKBITS, they saved 8 pounds of dynamite per foot of advance, or total of $223. – which more than paid for the cost of the CARSET JACKBITS!

CARSET JACKBIT

THE IR SUPER-BIT

SET WITH CARBOLOY INSERTS

manufactured exclusively by

Ingersoll-Rand

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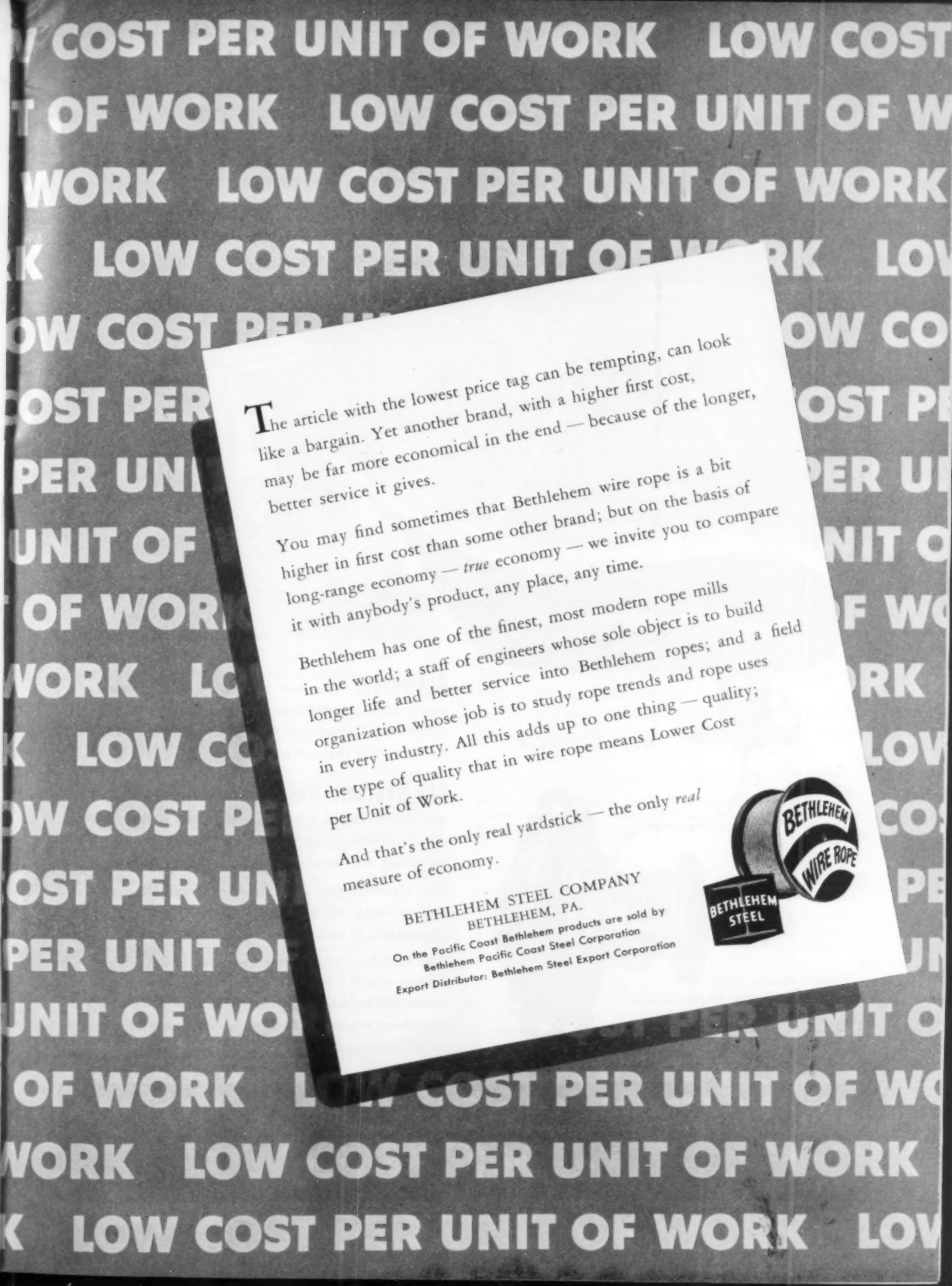

The article with the lowest price tag can be tempting, can look like a bargain. Yet another brand, with a higher first cost, may be far more economical in the end — because of the longer, better service it gives.

You may find sometimes that Bethlehem wire rope is a bit higher in first cost than some other brand; but on the basis of long-range economy — *true* economy — we invite you to compare it with anybody's product, any place, any time.

Bethlehem has one of the finest, most modern rope mills in the world; a staff of engineers whose sole object is to build longer life and better service into Bethlehem ropes; and a field organization whose job is to study rope trends and rope uses in every industry. All this adds up to one thing — quality; the type of quality that in wire rope means Lower Cost per Unit of Work.

And that's the only real yardstick — the only *real* measure of economy.

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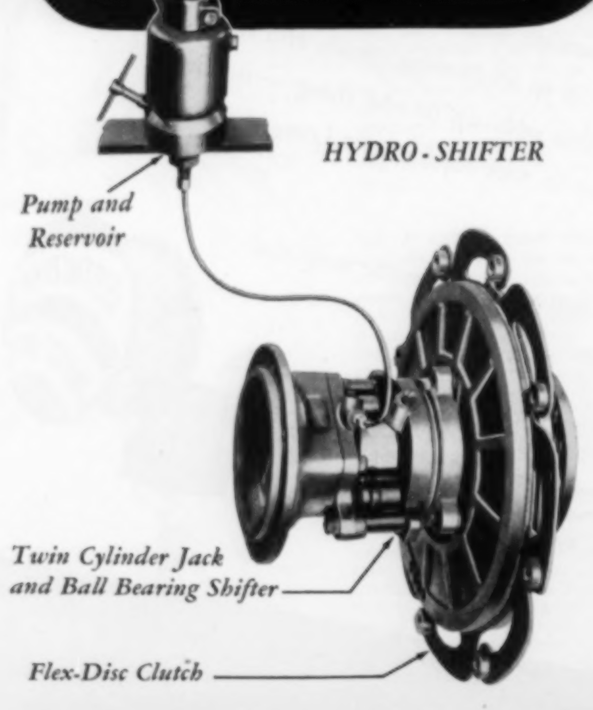
Anywhere in Any Weather


HYDRO - SHIFTER
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Twin Cylinder Jack and Ball Bearing Shifter
Flex-Disc Clutch

Anywhere. The new GKARC's with crawler treads have greatly increased the ability of I-R *Mobil-Air* Compressors to get anywhere they are needed under their own power.

Any Weather. The *Flex-Disc* Clutch with *Hydro-Shifter* has similarly increased the ability of the *Mobil-Air* Compressors fitted with it to operate under any conditions of weather or altitude.

The *Hydro-Shifter* gives finger-tip hydraulic control to make starting and stopping as easy and dependable in cold weather as in warm.

The *Flex-Disc* Clutch is a dependable, low maintenance clutch. The four interlocking clutch segments can be readily replaced when worn without disturbing engine or compressor or clutch adjustments or alignment.

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Waukesha Wisconsin

TOOL LIFE INCREASED
300%
*—reports farm equipment manufacturer**

REAMERS REAM *400* HOLES INSTEAD OF 4!
*—says machinery manufacturer**

HIGH SPEED DRILLS DULLED IN 30 MINUTES . . .
NOW WORK *90* HOURS BEFORE RESHARPENING
*—states machine tool manufacturer**

HI-SPEED-IT DID IT!

These actual on-the-job reports typify what hundreds of users say about *Hi-Speed-It,* the new steel hardening compound that hardens carbon and high speed steel tools and parts in a matter of minutes, and requires no baths, furnaces or special equipment of any kind.

In the standard procedure, illustrated below, *Hi-Speed-It* produces exceptional case hardness but with this vital difference—that there is a *gradual* change in hardness beneath the surface, producing a tough backing for the case. Your naked eye shows this "root" structure extends at least 1/16″ into the metal. By repeated treatment, *any* depth of hardness can be obtained.

Prove it yourself. Order *Hi-Speed-It* now under money-back guarantee it will do all we claim.

**Names upon request*

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Hi-Speed-It is a steel catalyst containing activated carbon made under Wilson Carbon Company, Inc. patent. Contains no cyanide or other producers of toxic fumes.

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STEEL-HARDENING COMPOUND
HI-SPEED-IT
NON-POISONOUS
Contains no cyanide or other toxic elements. Contains steel catalyst with activated carbon made under Wilson Carbon Company, Inc. patent. Standard packings: 2-5-10-25-100 lb.
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Send (state quantities) ☐ 2-lb. ☐ 5-lb. ☐ 10 lb. cans of *Hi-Speed-It* at $14 per lb., F.O.B. New York. (Also available in 25-lb. cans and 100-lb. drums with special discounts for 200 lb. or more. Send more information on *Hi-Speed-It.* ☐

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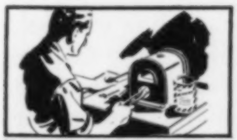
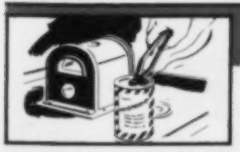
*Signed*____________________

EASY TO USE

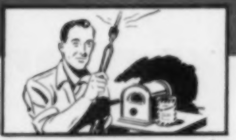
Here is the quick standard procedure.



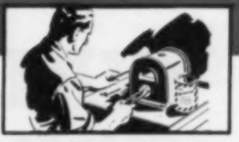
Heat tool or part to be hardened in torch, forge or furnace to cherry red color (1400° to 1700°F).



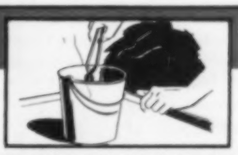
Immediately dip, stir or roll object in can of *Hi-Speed-It.*



Remove object from can, let it fuse from 15 to 30 seconds. Sprinkle with or dip lightly in *Hi-Speed-It.*



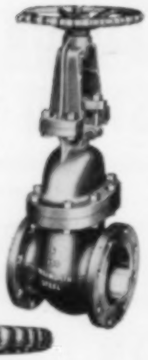
Reheat to cherry red until fusing is complete.



Quench quickly in clean, cold water or brine.

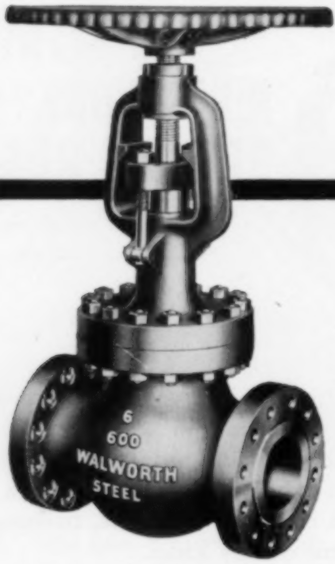
Complete instructions on every can give simple variations required for high speed steels, for greater depth of hardness, and for production-run hardening.

WILSON CARBON COMPANY, INC. • 60 East 42nd Street, New York 17, N. Y. • ***Technically Right Carbon Products for World Industries***



Walworth Series 150 Cast Steel Valves are tough and wear-resistant. Gate valves are available in sizes from 2″ to 24″, and globe valves in sizes 2″ to 12″.

Years of trouble-free service assured with . . .



Walworth Series 600 Cast Steel Valves have strength and ability to resist wear. They assure long life and positive operation. Available in either gate or globe types — Gate: sizes 1½″ to 18″ — Globe: sizes 2″ - 8″.

Walworth Pressure-Seal Cast Steel Gate Valves exemplify the greatest improvement in high-pressure, high-temperature valve design. The internal pressure keeps the body-to-bonnet joint tight. Series 600: 1½″ and larger — Series 900: 3″ and larger — Series 1500: 1″ and larger.

WALWORTH cast steel valves

Walworth Cast Steel Valves have proved their ability to assure years of trouble-free, dependable service. Accurately threaded stems, deep stuffing boxes, streamlined ports, and heavy cast alloy steel walls are their top features.

You can get full information about Walworth's complete line of steel, iron, and bronze valves and fittings from our new Catalog 47. See your nearest Walworth distributor, or write on business stationery for your free copy.

Walworth Cast Steel Fittings are manufactured in a wide range of types and sizes to meet every requirement. They are made to the highest standards of quality, both as to dimensional accuracy and metallurgical properties.

WALWORTH
valves and fittings
60 EAST 42nd STREET, NEW YORK 17, N. Y.

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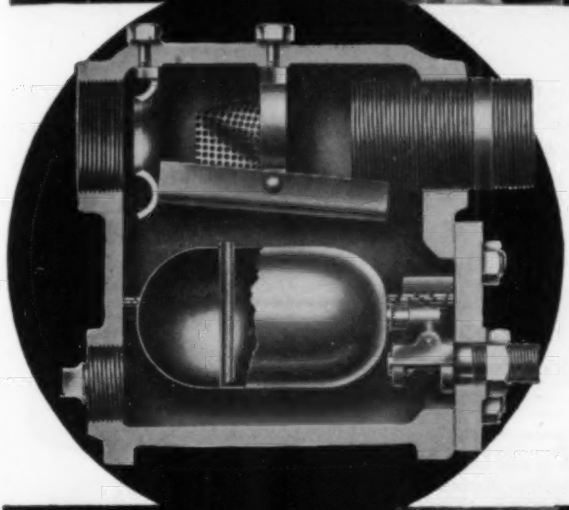

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SEPARATES • COLLECTS • DELIVERS

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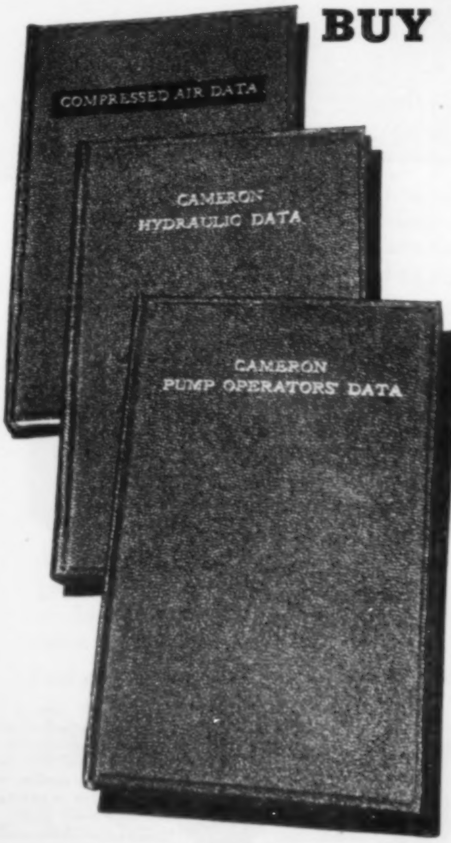
WRITE FOR BULLETIN DA WHICH FULLY DESCRIBES THE CONSTRUCTION AND OPERATION OF THE DRIAIR.

NEW JERSEY METER CO.

"SPECIALISTS IN COMPRESSED AIR DEVICES"

PLAINFIELD, NEW JERSEY



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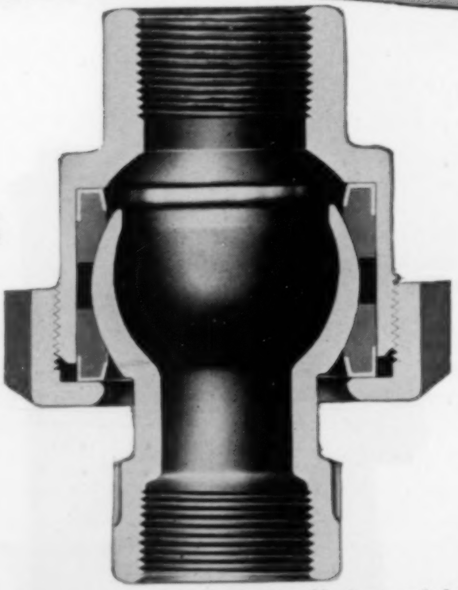

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WITH BARCO JOINTS

Operators of air, steam or hydraulic equipment find it necessary to have flexibility in their pipe lines to move the equipment while operating, or to take care of vibration, and prevent pipe breakage. There is no better way to accomplish this purpose than by the use of BARCO FLEXIBLE JOINTS, in connection with steel pipe. This combination will stand temperature, pressure, and abuse, which no other form of container will stand.

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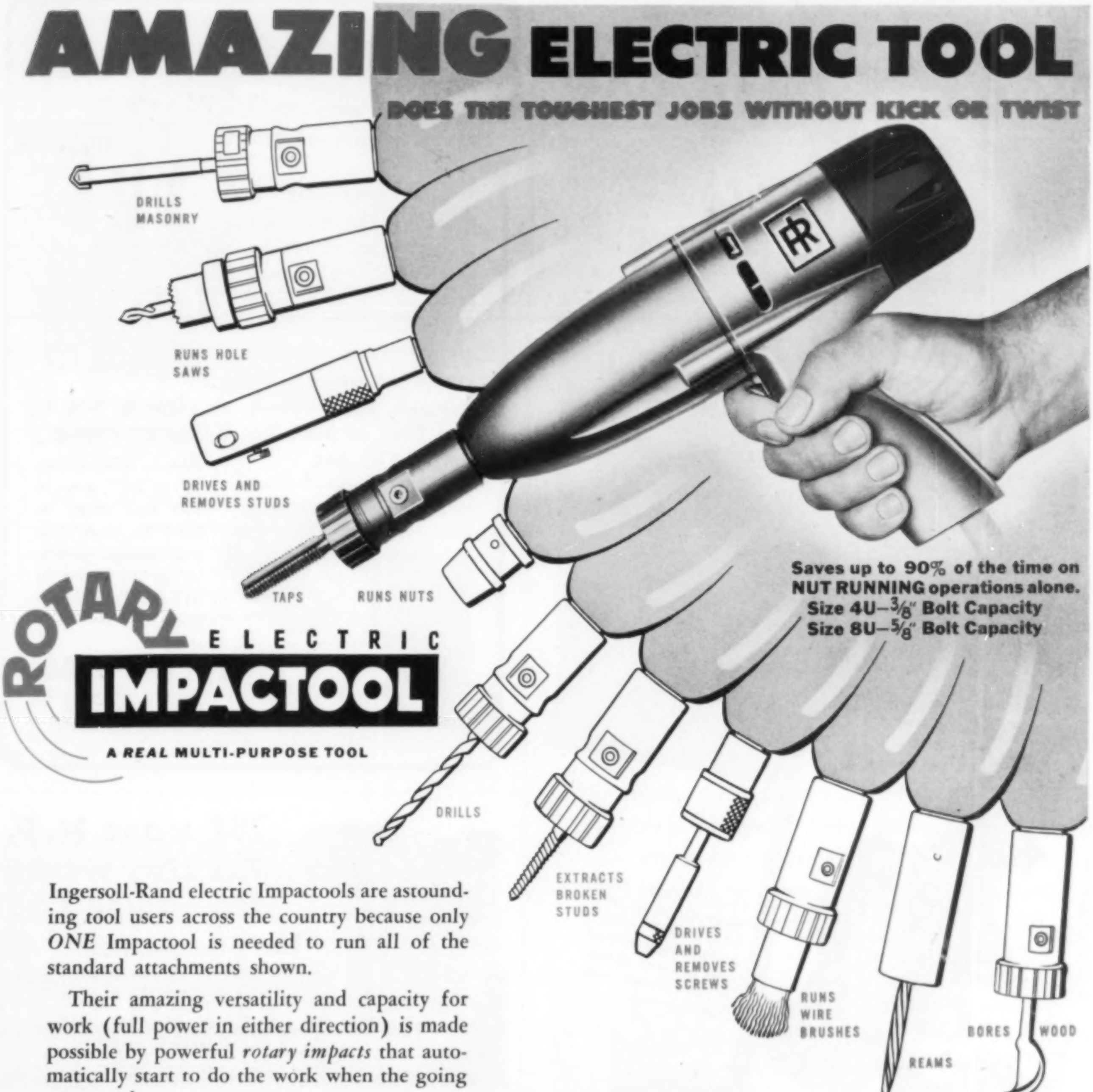
AMAZING ELECTRIC TOOL

DOES THE TOUGHEST JOBS WITHOUT KICK OR TWIST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Sold nationally through distributors and jobbers.

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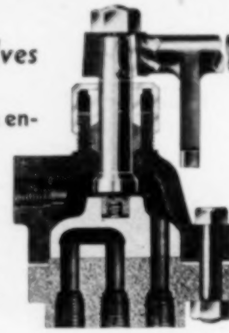

Our custom construction enables you to meet the problems presented by specific mediums and pressures; choice of 6 metal combinations. Other Nicholson features: specially treated hard seats; easily repacked; heavy-bodied; neat. Press. to 5000 lbs. CATALOG 546.

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W. H. NICHOLSON & CO.
180 OREGON ST., WILKES-BARRE, PA.
Valves ★ Traps ★ Steam Specialties

20% MORE H.P.
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That's the *new* MODEL AEN

WISCONSIN HEAVY-DUTY *Air-Cooled* ENGINE!

Replacing the universally popular Wisconsin Model AEH Air-Cooled Engine, the new Model AEN turns up 7.5 H.P. at 3,000 R.P.M. as against 6.1 H.P. at 3,200 R.P.M. delivered by the engine it replaces. Weight: 110 lbs., as against 130 lbs. for the AEH. Price: approximately 10% lower.

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The Model AEN represents a major achievement in the design and construction of a light weight heavy-duty power unit for all-purpose power applications. Write for Bulletin S-109.

The Wisconsin line includes 4-cycle single cylinder, 2- and 4-cylinder models in a complete power range from 2 to 30 H.P.

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WISCONSIN MOTOR CORPORATION
World's Largest Builders of Heavy-Duty Air-Cooled Engines
MILWAUKEE 14, WISCONSIN

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PUMP CONTROL
PRESSURE, FLOAT AND TEMPERATURE SWITCHES

Square D offers a wide range of pressure, float and temperature switches for practically all sizes of water pumps, condensate pumps, vacuum pumps, air compressors, machine tools and other machinery involving pneumatic or hydraulic systems. Send for your free copy of Pump Control Catalog, with illustrations and specifications.

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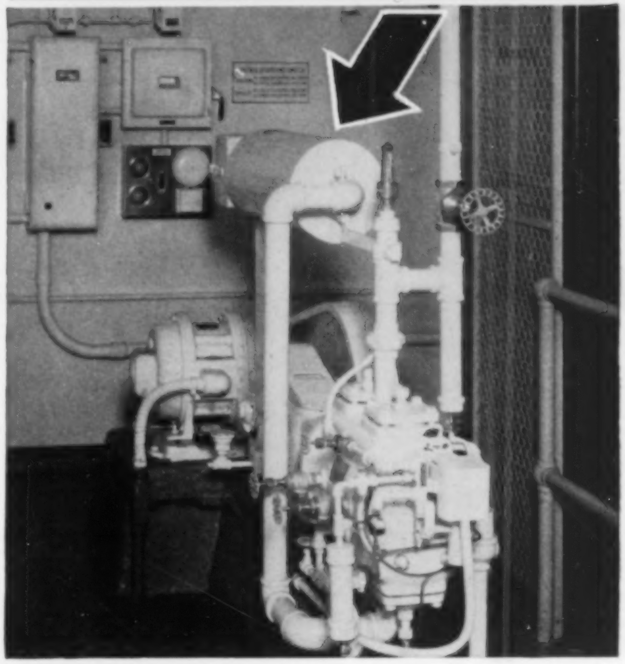
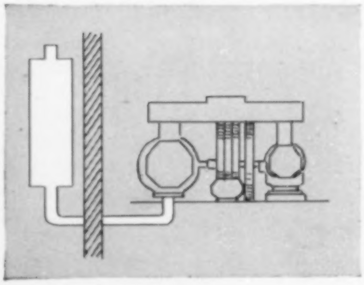
PROPER SILENCING MEANS BETTER OPERATION



The correct silencing equipment properly installed can make your compressor a good neighbor wherever you install it. Maxim intake silencers eliminate both noise and air borne vibration and insure quiet, efficient operation of compressors, large or small. It always pays to have a Maxim on the job.



There are several "right" ways to install a Maxim Silencer on your compressor depending upon location, space limitation, etc. Let our engineering department help you plan the best way for your particular conditions.

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THIS HOSE HAD AN ORDINARY RUBBER COVER

When new, it had excellent abrasion resistance. Yet it did not resist abrasion in use. Here's why: The cover was weakened by exposure to sunlight, heat, ozone, oil and grease. Abrasion merely *finished* the job.

Neoprene-covered air hose has lasting abrasion resistance because it retains its toughness

Most air hose withstands abrasion when new. But length of service life will depend on its ability to *retain* that property. Sunlight, ozone, weathering, heat and oil attack the cover of ordinary hose, gradually weaken it until it fails from abrasion after all.

In contrast, quality hose made with a neoprene cover withstands broiling sunlight, ozone, heat and oil. It won't crack or soften. So it stands up despite continual dragging and yanking over sharp rocks and rough terrain.

And, inside a hose, a neoprene tube won't disintegrate when exposed to hot lubricating oil, so no crumbled particles will clog tools. Here, too, neoprene retains its strength and toughness . . . protects fabric reinforcement from oil, heat, and moisture, which rot the fabric and lead to blowouts.

So make sure of long service life . . . low replacement costs on the air hose you use. Ask your supplier for hose made with neoprene tube and cover.

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SPECIFY HOSE MADE OF

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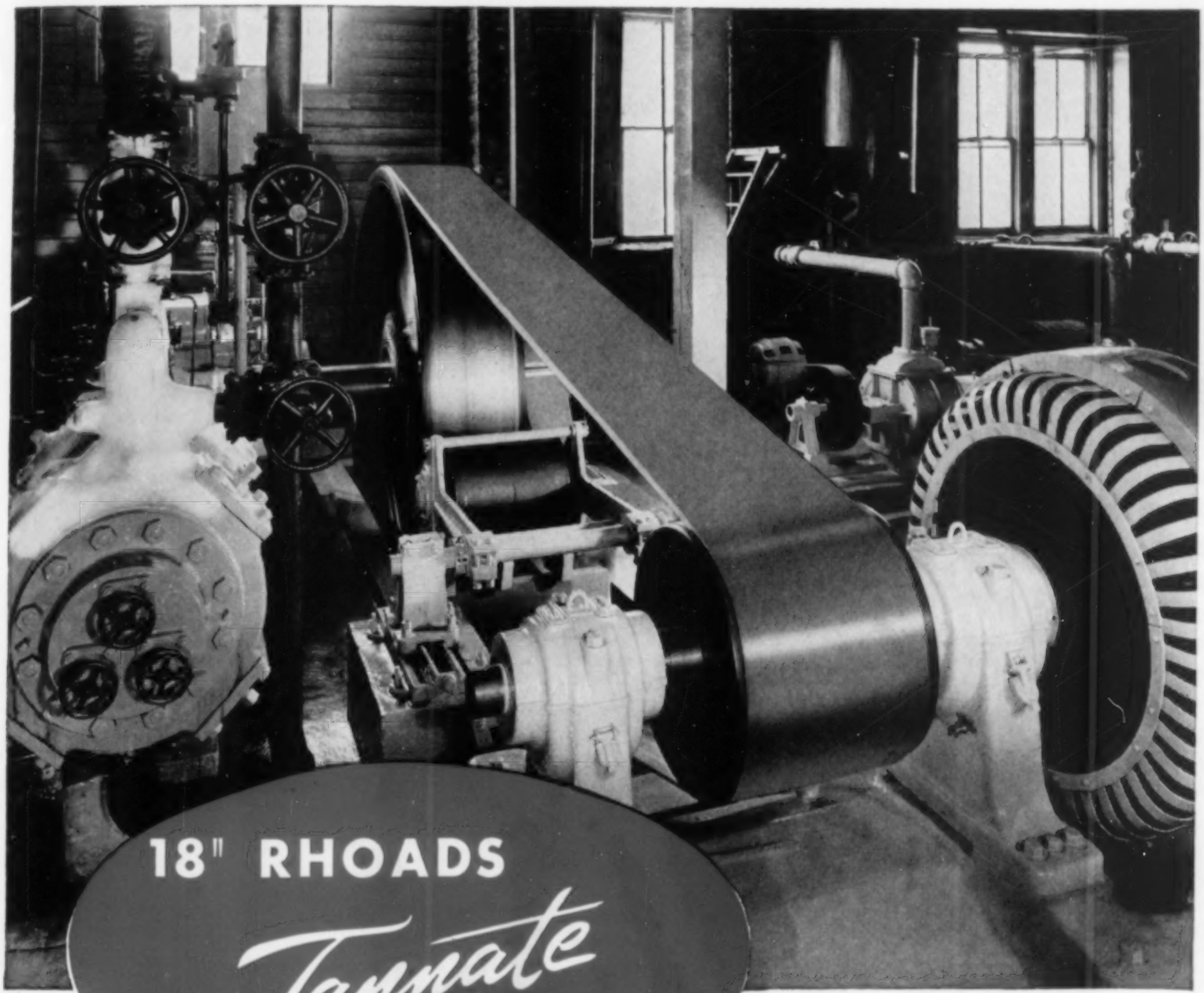
The rubber made by Du Pont

Tune in Du Pont "Cavalcade of America," Monday nights—NBC coast to coast.



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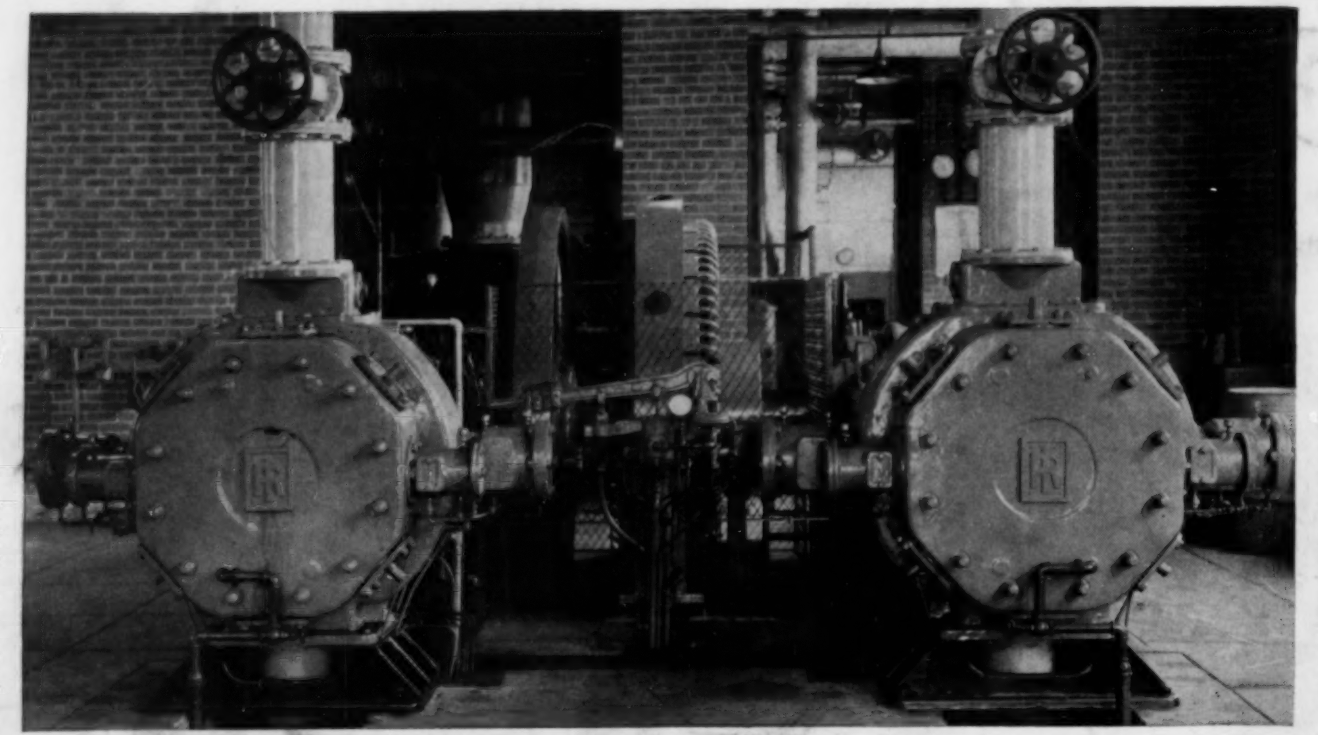

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